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ABSTRACT

This module is designed to provide students (grades 10-11) with experiences in examining how technology has changed our lives and in anticipating future changes. The module is divided into three sections. Role-playing simulations and readings are used in section 1 to examine the dynamic relationship between science/technology/society. Five technologies (mind control, solar energy, genetic engineering, remote sensing, computers/artificial intelligence) are examined in section 2 through readings and dilemma/discussions. Dilemmas are brief stories posing a critical decision to be made by a main character. This decision revolves around conflicts between two or more moral/ethical issues (as identified by Kohlberg) presented in the situation, and it is the moral/ethical implication that provides the thrust for later student discussions. Preceding each dilemma are readings/case studies providing background information regarding issues in the dilemma. Questions are also provided to stimulate thinking about the issues and to generate discussions. Section 3 is a simulation offering students an opportunity to select technologies for the future. The module may be used as a separate unit of study, as a mini-course, or incorporated into such subject areas as general science, history, language arts, social science, or chemistry. (JN)

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PREPARING FOR TOMORROW'S WORLD

TECHNOLOGY AND SOCIETY:
A Futuristic Perspective

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- Technology and Society: A Futuristic Perspective

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PREPARING FOR TOMORROW'S WORLD

TECHNOLOGY AND SOCIETY:
A Futuristic Perspective

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PREFACE

We live in an exciting, rapidly changing, and challenging world—a world highly dependent upon science and technology. Our world is changing so rapidly that we sometimes fail to recognize that much of what we today take for granted as common, everyday occurrences existed only in the imaginations of people just a few short years ago. Advances in science and technology have brought many dreams to fruition. Long before today's school children become senior citizens, much of today's "science fiction" will, in fact, become reality. Recall just a few accomplishments which not long ago were viewed as idle dreams:

- *New biomedical advances have made it possible to replace defective hearts, kidneys and other organs.*
- *The first air flight at Kitty Hawk lasted only a few seconds. Now, a little over half a century later space ships travel thousands of miles an hour to explore distant planets.*
- *Nuclear technology—of interest a few short years ago because of its destructive potential—could provide humankind with almost limitless supplies of energy for peace-time needs.*
- *Computer technology has made it possible to solve in seconds problems which only a decade ago would require many human lifetimes.*
- *Science and technology have brought us to the brink of controlling weather, earthquakes and other natural phenomena.*

Moreover, the changes which we have been experiencing and to which we have become accustomed are occurring at an increasingly rapid rate. Changes, most futurists forecast, will continue and, in fact, even accelerate as we move into the 21st Century and beyond. But, as Barry Commoner has stated, "There is no such thing as a free lunch." These great advances will not be achieved without a high price. We are now beginning to experience the adverse effects of our great achievements:

- *The world's natural resources are being rapidly depleted.*
- *Our planet's water and air are no longer pure and clean.*
- *Thousands of plant and animal species are threatened with extinction.*
- *Nearly half the world's population suffers from malnutrition.*

While science and technology have given us tremendous power, we are also confronted with an awesome responsibility: to use the power and ability wisely, to make equitable decision tradeoffs, and to make valid and just choices when there is no absolute "right" alternative. Whether we have used our new powers wisely is highly questionable.

Today's youth will soon become society's decision-makers. Will they be capable of improving upon the decision-making of the past? Will they possess the skills and abilities to make effective, equitable, long-range decisions to create a better world?

To the student:

This module has been prepared to help you—the student and future decision maker—function more effectively in a rapidly changing world. Other modules in the *Preparing for Tomorrow's World* program focus on additional issues of current and future importance.

To the teacher:

It is our belief that this module—and indeed the entire *Preparing for Tomorrow's World* program—will help you the teacher prepare the future decision-maker to deal effectively with issues and challenges at the interfaces of science/technology/society. It is our belief that the contents and activities in this program will begin to prepare today's youth to live life to the fullest, in balance with Earth's resources and environmental limits, and to meet the challenges of tomorrow's world.

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Section One:

TECHNOLOGY AND CHANGE

From the earliest times when humans fashioned their first tools, how they lived and the world they lived in changed in many different ways. Tools extended human power and offered new opportunities and techniques for survival. The development of farming tools and agricultural knowledge, for example, made it possible for the once migratory hunters to establish permanent settlements. Groups of small roving bands now became farming communities. An agricultural way of life brought about new types and styles of social organizations, shelters, foods, eating habits, and clothing. It required new forms of knowledge such as weights and measures as well as engineering to build irrigation systems. The land of forests and plains became transformed into checkerboards of planted rows, interlaced with canals carrying water. The earth's environment thus took on new characteristics with the development of new techniques, tools and machines.

Although technology has been an integral part of human existence since its earliest beginning, we tend to think of our modern times as the "age of technology."

What does the "age of technology" mean?

Does technology today differ very much from technology of the past?

Is it because we use so many products made by machines?

Is it because of the increased numbers of new inventions?

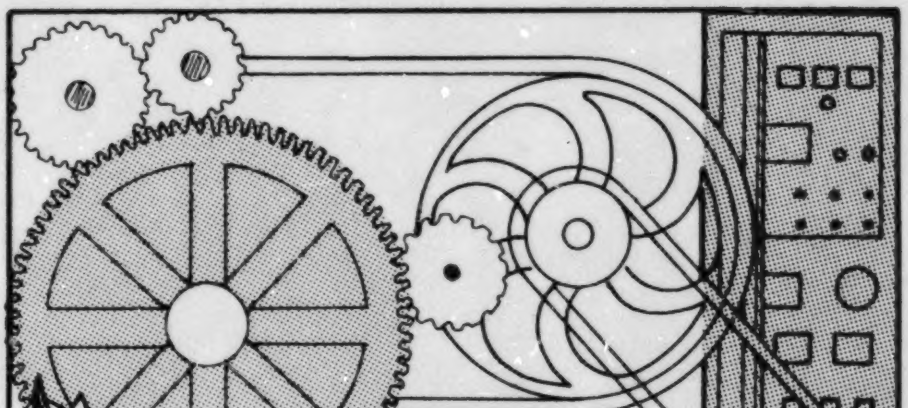
Is it because machines have drastically changed the way we work and live?

Is it because changes are taking place so rapidly?

Is it because we have acquired more powerful tools?

One way in which we can examine the meaning of technology and its interrelationship with our lives is to look at some of the recent technological innovations that emerged in the past century. The following activity — *A Technology Inventory* — is a graphic way of charting changes and effects.

THE IMPACT OF TECHNOLOGY



Activity 1: Technology Inventory

In this activity you will select one technology and examine how it has affected or changed different areas of human activity. You will also consider the types of resources required by the technology as well as the changes it has created. Some of the effects are immediately obvious, while others are less so. A good way to approach this activity is to ask yourself the question, "What would life be like if this technology had *not* been developed?"

Procedure

- You will first complete the chart on Handout 1. Your teacher will distribute a copy of this sheet.
- Select one of the technologies listed below and enter it in the top box entitled *New Technology.*
- Under this box are listed three categories: *Changes, Resource Requirements,* and *Consequences.* For each category are a number of subheadings and corresponding boxes. Fill in the boxes with your ideas on the subject.
- *Technologies of the Modern Age*
  - AUTOMOBILES
  - AIRPLANES
  - MASS PRODUCTION INDUSTRIALIZATION
  - ELECTRICITY
  - TELEPHONES
  - ANTIBIOTICS
  - TELEVISION
  - SKYSCRAPERS
  - FERTILIZERS AND PESTICIDES

The following are just a few brief comments regarding industrialization. They are intended to offer some beginning thoughts which you can further elaborate upon to complete the example.

Discussion of Results

— After completing your worksheet, meet in small groups of 3 to 4 members. Share with other group members your ideas. Did any other person in your group select the same topic? In what ways were your ideas similar? Dissimilar? Do you disagree with any of the items on their lists?

— When each person in the group has presented his/her chart, discuss some of the questions below.

- Were there any ideas that were common in all the charts? What were they?
- In what ways did life change as the result of these new technologies?
- What types of adjustments did people need to make in order to use the new technologies? Was it difficult to make these adjustments?
- Did the application of the new technology depend upon other types of new developments? What are some of these developments?
- What new opportunities became available to people as the result of the technology?
- What do you think are the major benefits of modern technology? Explain.
- What unpredicted changes do you think have been most detrimental? Explain.
- What is your definition of technology?

EXAMPLE: Let us, as an example, consider a new technology of mass production/ industrialization. One of the questions we need to answer is, "How has mass production affected or changed the INDIVIDUAL, COMMUNITY, BUSINESS and GOVERNMENT?" In the box titled INDIVIDUAL, one might list:

- *work on assembly lines*
- *work is repetitive*
- *work schedule is regulated*
- *people pay less for mass produced products*
- *people enjoy more labor saving products*

COMMUNITY effects might include:

- *small craft shops replaced by factories*
- *industrial towns and cities are built*
- *people moved from farms*

BUSINESS effects might include:

- *standardized products*
- *greater efficiency*
- *need for large capital investments to build large factory and new machinery*
- *rise of large corporations*

GOVERNMENT effects might include:

- *enact laws to protect workers, insure product safety, etc.*
- *build roads*
- *standard of living of country is raised*

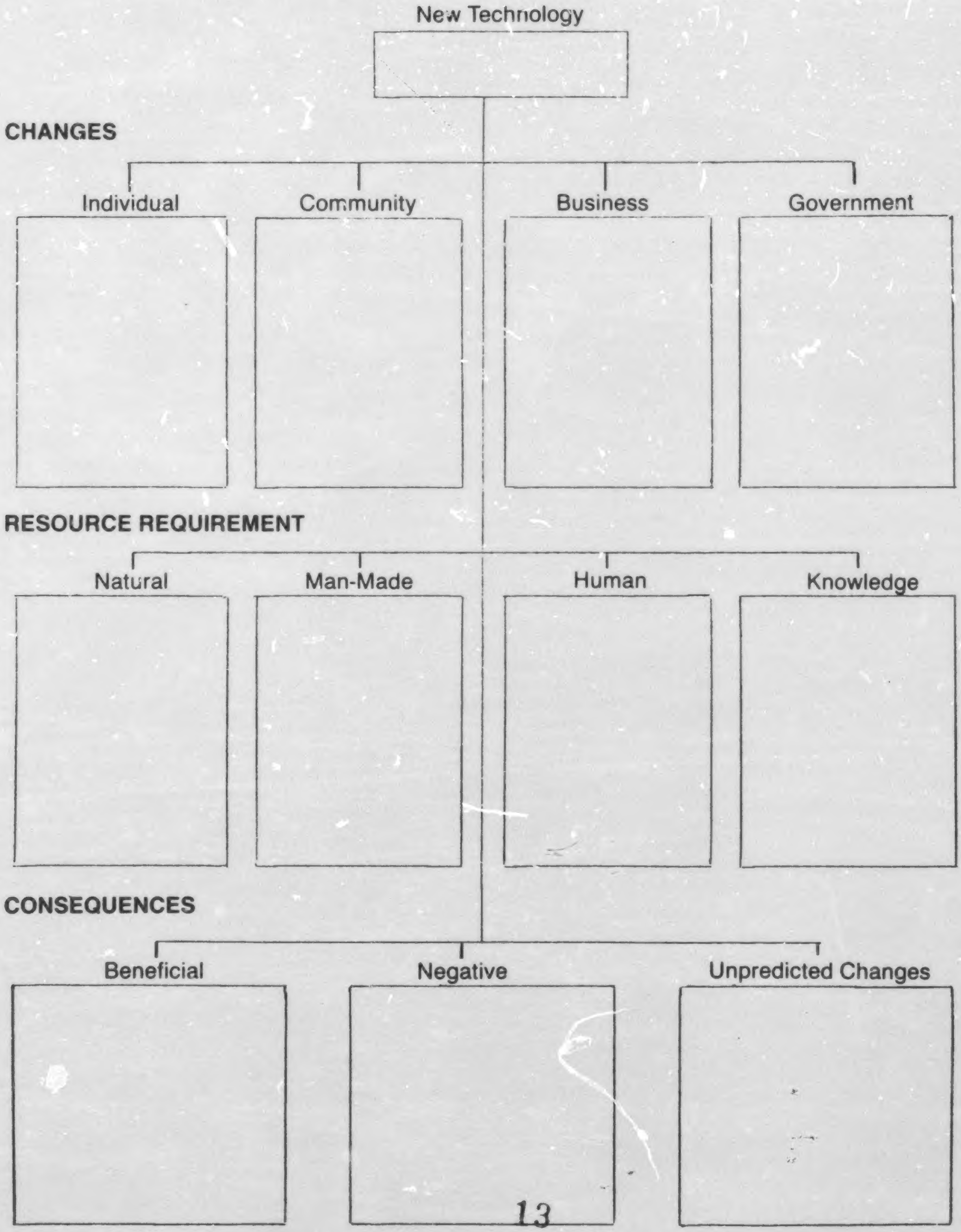
The items for the other categories will emerge as one begins to think about the processes, materials and structures needed for industrialization. Operating machines required large quantities of energy. Hence, factories were located near sources of power, or they generated their own power. If coal provided the fuel source, railroads had to be built to transport the coal. A rapid means of communication needed to be developed so that supplies could be located and ordered efficiently. Filling orders and delivery of goods also depended on a combination of new communications and transportation systems. With industrialization came developments in the scientific organization of work. It became important to know how to best divide the various tasks so that the production line would operate most efficiently. The clock and accurate timing of each task became a critical factor in the system, and "time and motion" engineers or efficiency experts entered the factory scene.

Industrialization depended upon a variety of raw materials and large quantities of them. Mining of iron ore and steel making reached new heights with increased demands for machinery to produce goods. Mining left unsightly scars on the landscape. Manufacturing processes also produced wastes in the form of by-products, chemicals, smoke, and so on. The disposal of these wastes, which was a lesser concern in the early days of industrialization, became in more recent years a critical and dangerous problem.

How people responded to industrialization has been the subject of countless books, research and even movies. Workers flocked to cities for new job opportunities and higher wages. More people enjoyed goods that were once limited to the rich because the assembly lines made it possible to produce abundantly at lower costs. Yet, there was growing feeling that work was no longer a creative and individual enterprise. It was now tied to the machine — one worked as a part of the machine system. Although the machine lifted the burdens of some types of work, it required workers to perform other tasks in a systematic, repetitive manner. On the other hand, working days were shorter, and leisure time became a larger aspect of one's life.

STUDENT HANDOUT ONE

TECHNOLOGY INVENTORY



WHAT IS TECHNOLOGY?

"Technos" comes from the Greek word for an art or skill. "Technologia," another Greek word, refers to the systematic treatment of an art. In more recent times, we have used the word technology to mean an applied science. Other definitions in *Webster's Dictionary* include, "a technical means of achieving a practical purpose" and "the totality of means employed to provide objects necessary for human sustenance and comfort." These definitions of technology include the products and processes that are directed towards human benefits and improvement of life. Moreover, according to the definition, there are many different components of a given technology. For instance, is the development of television merely the development of the television set? What other components or activities are necessary before you can flick on a switch and enjoy a program?

Technology today, then, is more than a mere tool or machine. When you completed the previous activity you no doubt recognized that a technology encompassed a complex interconnecting network system. Norman Balabanian,[1] for example, has classified the elements of technology in the following manner: *physical objects, knowledge, human beings, organization and system* and *political and economic power.* He describes the elements of television technology as follows:

— *The physical objects of television technology would include the receiving set, transmission towers, recording cameras, film, and all the machines used in transmitting programs as well as those used in producing the receivers and transmitters.*

— *Knowledge includes the "know how" to install, operate and maintain the system, ranging from scientific principles of electronic signals to the operation of TV cameras.*

— *Human beings are involved in operating the machinery as well as producing shows and writing scripts and must be trained in their various roles.*

— *The organization and system, in the technology of television, include the management of people in the industry, defining the tasks and activities that must be accomplished, manufacturing and marketing television sets as well as responding to the preferences of the audiences.*

— *Political and economic power include the goals of TV companies to be profitable and the advertisers to sell products. Licensing of TV stations determines who can broadcast and the types of shows to be aired.*

Thus, the application of a technology which includes devices as well as systematic patterns of thought and activity has widespread and often all-encompassing effects. These effects influence and shape our social, economic, cultural and political institutions. Critics of technology, however, have raised a number of questions:

— Do we control technology or does technology control us?

— Is technology developing so rapidly that we are unable to adjust to the changes?

— Are the adverse effects of technology greater than its benefits?

— Does the use of technology to solve a problem create more new problems?

— Has technology made us more machine-like and less human?

While these questions have no simple answers, we can begin to examine some of the issues raised by technology in the following activities.

---

[1] Norman Balabanian. "Technology, Freedom and Individual Autonomy." *Science, Technology* and *Society,* #15, December 1979.

TECHNOLOGY AND WORK

Reading 1

The "Industrial Revolution" in the Home: Household Technology and Social Change in the 20th Century

RUTH SCHWARTZ COWAN

When we think about the interaction between technology and society, we tend to think in fairly grandiose terms: massive computers invading the workplace, railroad tracks cutting through vast wildernesses, armies of woman and children toiling in the mills. These grand visions have blinded us to an important and rather peculiar technological revolution which has been going on right under our noses: the technological revolution in the home. This revolution has transformed the conduct of our daily lives, but in somewhat unexpected ways. The industrialization of the home was a process very different from the industrialization of other means of production, and the impact of that process was neither what we have been led to believe it was nor what students of the other industrial revolutions would have been led to predict.

* * *

The *Ladies' Home Journal* has been in continuous publication since 1886. A casual survey of the nonfiction in the *Journal* yields the immediate impression that that decade between the end of World War I and the beginning of the depression witnessed the most drastic changes in patterns of household work. Statistical data bear out this impression. Before 1918, for example, illustrations of homes lit by gaslight could still be found in the *Journal;* by 1928 gaslight had disappeared. In 1917 only one-quarter (24.3 percent) of the dwellings in the United States had been electrified, but by 1920 this figure had doubled (47.4 percent—for rural nonfarm and urban dwellings), and by 1930 it had risen to four-fifths percent). If electrification had meant simply the change from gas or oil lamps to electric lights, the changes in the housewife's routines might not have been very great (except for eliminating the chore of cleaning and filling oil lamps); but changes in lighting were the least of the changes that electrification implied. Small electric appliances followed quickly on the heels of the electric light, and some of those augured much more profound changes in the housewife's routine.

Ironing, for example, had traditionally been one of the most dreadful household chores, especially in warm weather when the kitchen stove had to be kept hot for the better part of the day; irons were heavy and they had to be returned to the stove frequently to be reheated. Electric irons eased a good part of this burden. They were relatively inexpensive and very quickly replaced their predecessors; advertisements for electric irons first began to appear in the ladies' magazines after the war, and by the end of the decade the old flatiron had disappeared; by 1929 a survey of 100 Ford employees revealed that ninety-eight of them had the new electric irons in their homes.

Data on the diffusion of electric washing machines are somewhat harder to come by; but it is clear from the advertisements in the magazines, particularly advertisements for laundry soap, that by the middle of the 1920s those machines could be found in a significant number of homes. The washing machine is depicted just about as frequently as the laundry tub by the middle of the 1920s; in 1929, forty-nine out of those 100 Ford workers had the machines in their homes. The washing machines did not drastically reduce the time that had to be spent on household laundry, as they did not go through their cycles automatically and did not spin dry; the housewife had to stand guard, stopping and starting the machine at appropriate times, adding soap, sometimes attaching the drain pipes, and putting the clothes through the wringer manually. The machines did, however, reduce a good part of the drudgery that once had been associated with washday, and this was a matter of no small consequence. Soap powders appeared on the market in the early 1920s, thus eliminating the need to scrape and boil bars of laundry soap. By the end of the 1920s Blue Monday must have been considerably less blue for some housewives—and probably considerably less "Monday," for with an electric iron, a washing machine, and a hot water heater, there was no reason to limit the washing to just one day of the week.

* * *

Many of the changes just described—from hand power to electric power, from coal and wood to gas and oil as fuels for cooking, from one-room heating to central heating, from pumping water to running water—are enormous technological changes. Changes of a similar dimension, either in the fundamental technology of an industry, in the diffusion of that technology, or in the routines of workers, would have long since been labeled an "industrial revolution." The change from the laundry tub to the washing machine is no less profound than the change from the hand loom to the power loom; the change from pumping water to turning on a water faucet is no less destructive of traditional habits than the change from manual to electric calculating. It seems odd to speak of an "industrial revolution" connected with housework, odd because we are talking about the technology of such homely things, and odd because we are not accustomed to thinking of housewives as a labor force or of housework as an economic commodity—but despite this oddity, I think the term is altogether appropriate.

In this case other questions come immediately to mind, questions that we do not hesitate to ask, say, about textile workers in Britain in the early 19th century, but we have never thought to ask about housewives in America in the 20th century. What happened to this particular work force when the technology of its work was revolutionized? Did structural changes occur? Were new jobs created for which new skills were required? Can we discern new ideologies that influenced the behavior of the workers?

The answer to all of these questions, surprisingly enough, seems to be yes. There were marked structural changes in the work force, changes that increased the work load and the job description of the workers that remained. New jobs were created for which new skills were required; these jobs were not physically burdensome, but they may have taken up as much time as the jobs they had replaced. New ideologies were also created, ideologies which reinforced new behavioral patterns, patterns that we might not have been led to expect if we had followed the sociologists' model to the letter. Middle-class housewives, the women who must have first felt the impact of the new household technology, were not flocking into the divorce courts or the labor market or the forums of political protest in the years immediately after the revolution in their work. What they were doing was sterilizing baby bottles, shepherding their children to dancing classes and music lessons, planning nutritious meals, shopping for new clothes, studying child psychology, and hand stitching color-coordinated curtains—all of which chores (and others like them) the standard sociological model has apparently not provided for.

The significant change in the structure of the household labor force was the disappearance of paid and unpaid servants (unmarried daughters, maiden aunts, and grandparents fall in the latter category) as household workers—and the imposition of the entire job on the housewife herself. Leaving aside for a moment the question of which was cause and which effect (did the disappearance of the servant create a demand for the new technology, or did the new technology make the servant obsolete?), the phenomenon itself is relatively easy to document. Before World War I, when illustrators in the women's magazines depicted women doing housework, the women were very often servants. When the lady of the house was drawn, she was often the person being served, or she was supervising the serving, or she was adding an elegant finishing touch to the work. Nursemaids diapered babies, seamstresses pinned up hems, waitresses served meals, laundresses did the wash, and cooks did the cooking. By the end of the 1920s the servants had disappeared from those illustrations; all those jobs were being done by housewives—elegantly manicured and coiffed, to be sure, but housewives nonetheless.

* * *

As the number of household assistants declined, the number of household tasks increased. The middle-class housewife was expected to demonstrate competence at several tasks that previously had not been in her purview or had not existed at all. Child care is the most obvious example. The average housewife had fewer children than her mother had had, but she was expected to do things for her children that her mother would never have dreamed of doing: to prepare their special infant formulas, sterilize their bottles, weigh them every day, see to it that they ate nutritionally balanced meals, keep them isolated and confined when they had even the slightest illness, consult with their teachers frequently, and chauffeur them to dancing lessons, music lessons, and evening parties. There was very little Freudianism in this new attitude toward child care: mothers were not spending more time and effort on their children because they feared the psychological trauma of separation, but because competent nursemaids could not be found, and the new theories of child care required constant attention from well-informed persons—persons who were willing and able to read about the latest discoveries in nutrition, in the control of contagious diseases, or in the techniques of behavioral psychology. These persons simply had to be their mothers.

Consumption of economic goods provides another example of the housewife's expanded job description; like child care, the new tasks associated with consumption were not necessarily physically burdensome, but they were time consuming, and they required the acquisition of new skills. Home economists and the editors of women's magazines tried to teach housewives to spend their money wisely. The present generation of housewives, it was argued, had been reared by mothers who did not ordinarily shop for things like clothing, bed linens, or towels; consequently modern housewives did not know how to shop and would have to be taught. Furthermore, their mothers had not been accustomed to the wide variety of goods that were now available in the modern marketplace; the new housewives had to be taught not just to be consumers, but to be informed consumers. Several contemporary observers believed that shopping and shopping wisely were occupying increasing amounts of housewives' time.

Several of these contemporary observers also believed that standards of household care changed during the decade of the 1920s. The discovery of the "household germ" led to almost fetishistic concern about the cleanliness of the home. The amount and frequency of laundering probably increased, as bed linen and underwear were changed more often, children's clothes were made increasingly out of washable fabrics, and men's shirts no longer had replaceable collars and cuffs. Unfortunately all these changes in standards are difficult to document, being changes in the things that people regard as so insignificant as to be unworthy of comment; the improvement in standards seems a likely possibility, but not something that can be proved.

In any event we do have various time studies which demonstrate somewhat surprisingly that housewives with conveniences were spending just as much time on household duties as were housewives without them—or, to put it another way, housework, like so many other types of work, expands to fill the time available. A study comparing the time spent per week in housework by 288 farm families and 154 town families in Oregon in 1928 revealed 61 hours spent by farm wives and 63.4 hours by town wives; in 1929 a U.S. Department of Agriculture study of families in various states produced almost identical results. Surely if the standard sociological model were valid, housewives in towns, where presumably the benefits of specialization and electrification were most likely to be available, should have been spending far less time at their work than their rural sisters. However, just after World War II economists at Brvn Mawr College reported the same phenomenon: 60.55 hours spent by farm housewives, 78.35 hours by women in small cities, 80.57 hours by women in large ones—precisely the reverse of the results that were expected. A recent survey of time studies conducted between 1920 and 1970 concludes that the time spent on housework by nonemployed housewives has remained remarkably constant throughout the period. All these results point in the same direction: mechanization of the household meant that time expended on some jobs decreased, but also that new jobs were substituted, and in some cases—notably laundering—time expenditures for old jobs increased because of higher standards. The advantages of mechanization may be somewhat more dubious than they seem at first glance.

* * *

The housewife is just about the only unspecialized worker left in America—a veritable jane-of-all-trades at a time when the jacks-of-all-trades have disappeared. As her work became generalized the housewife was also proletarianized: formerly she was ideally the manager of several other subordinate workers; now she was idealized as the manager and the worker combined. Her managerial functions have not entirely disappeared, but they have certainly diminished and have been replaced by simple manual labor; the middle-class, fairly well educated housewife ceased to be a personnel manager and became, instead, a chauffeur, charwoman, and short-order cook. The implications of this phenomenon, the proletarianization of a work force that had previously seen itself as predominantly managerial, deserve to be explored at greater length than is possible here, because I suspect that they will explain certain aspects of the women's liberation movement of the 1960s and 1970s which have previously eluded explanation: why, for example, the movement's greatest strength lies in social and economic groups who seem, on the surface at least, to need it least—women who are white, well-educated, and middle-class.

Finally, instead of desensitizing the emotions that were connected with household work, the industrial revolution in the home seems to have heightened the emotional context of the work, until a woman's sense of self-worth became a function of her success at arranging bits of fruit to form a clown's face in a gelatin salad. That pervasive social illness, which Betty Friedan characterized as "the problem that has no name," arose not among workers who found that their labor brought no emotional satisfaction, but among workers who found that their work was invested with emotional weight far out of proportion to its own inherent value.

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[1] Excerpts from paper appearing in *Technology and Culture 17* (1976) © 1976 by the Society for the History of Technology. All rights reserved. Reprinted
permission.

Activity 2: Technology And Changing Work Roles

You have no doubt heard the complaint, "The work of the mother and housewife never ends." While we recognize that the demands of child care and the household extend the 24-hour day, we seldom think about the extensive skills required to manage today's technological house. Compared to women in the career world, the role of homemaker is not viewed as one requiring many talents. Yet as the preceding article pointed out, the modern homemaker has had to develop competency in many areas, learning and acquiring new skills on the job. More often than not, these skills are not recognized or appreciated when the homemaker tries to enter the job market. Also, the homemaker herself is not cognizant of her own competencies and in many instances seeks lesser, unskilled positions.

In this activity you will put yourself in the role of a housewife who is seeking a position in the business world. You will respond to the *Want Ad* on next page by writing a resume describing your qualifications.

YOUR ROLE DESCRIPTION:

You are Susan Bell who finished two years of college in liberal arts before your marriage. For the past 15 years you have been a housewife raising three children. Now that your children are starting high school, you feel that you can begin to develop your own career. You believe that during your years at home you have developed knowledge and skills in a wide range of areas and that much of what you learned is readily transferable to the business world. Although you have not been trained in the formal classroom setting, you consider yourself having experience in management. Maintaining the household, training children, holding offices in volunteer community organizations, coordinating schedules and budget planning all add up to a substantial amount of knowledge and acquired skills. For example, you have had to follow business trends and developments in order to invest the family savings profitably, building up funds for the children's college tuition. You keep up with advances in science and technological innovations in order to buy and use products wisely. Something seemingly as routine and basic as meal planning and grocery shopping requires efficient organization, so that time, money and effort are most effectively expended.

Your husband's company has offices throughout the country. Each of his promotions has meant moving to another office. So far, you have moved four times and have lived on the East Coast, in the Midwest, and on the West Coast. While the logistics of packing and moving furniture from one house to another were major productions in and of themselves, there were a variety of other tasks. They included selling and buying houses, locating new schools and lessons for the children, establishing credit, learning about the new community, finding new doctors, helping the children adjust to the changes, and so on. In your many moves you have learned to be flexible and adaptable to different situations. In your several moves there were always unexpected crises that required quick thinking and good judgment.

YOUR TASK:

You will compose a resume which summarizes your skills and competencies and demonstrates that you are qualified for the position advertised in the want ad below.

Help Wanted: Top management position in a fast expanding company. Responsibilities include managing a department of twenty, coordinating the development and marketing of a new product line, supervising the training of sales personnel and long range planning. Ideal candidate must be

- experienced in scheduling activities and budget management
- able to interact with people at all levels and respond to their wide range of needs
- a creative thinker, self starter and able to perform a diversity of activities
- a good problem solver
- knowledgeable and aware of changing trends

This is an excellent opportunity for an individual desiring a challenging and lucrative career with a diversified food manufacturer. Salary is commensurate with experience and includes a comprehensive benefits package.

Equal Opportunity Employer

Send resume to Personnel Department, Box 40, Uptown Station, New York, N.Y.

PROCEDURE:

- Review Reading 1: *The "Industrial Revolution" in the Home.* Consider how different technological developments have created demands for new types of skills. Consider also the complexities of managing today's home. What types of things must one know today that perhaps your grandmother did not need to know?
- Make a list of some of the skills that a homemaker acquires "on the job." Compare these skills with skills you think are required of a manager in business. Which ones are similar? Which ones are different?
- What new technologies have recently come into the home? Do they require new and different skills or knowledge? How have technological innovations helped to expand your knowledge of the world? For instance, in what ways does a housewife have to keep up with the new developments, changes, and trends in order to better manage and maintain the home and respond to the needs of the family? It is important to keep up with the news about advances in medical research, chemistry, etc.?
- Select what you think are the most important experiences and special skills that are relevant for the position you are seeking.
- Write your resume and include all those competencies which you think will convince the employer that you have developed unique skills during your years at home. Respond to the requirements of the Want Ad by demonstrating ways in which you acquired the competencies. Try to translate the description of roles and activities of a housewife into the language of the business world.
- Remember also that you want to start at the management level rather than as a trainee. It is important to show how effectively and successfully you have performed your complex role.

WHAT IS A RESUME?

Resume translated from the French simply means *summary.* This is usually the first piece of information that a job applicant sends to a prospective employer citing one's training and work experience. It is usually one or two pages (at most) in length and contains the basic facts about the applicant. Serving as the initial screening, it must therefore create an appealing image of the applicant. There is no one standard format for writing a resume, and different types of jobs may require different types of resumes. What aspects are emphasized will depend on what the employer is looking for. For the most part, the following categories of information are included:

Personal Data: Name, address, phone

Career Objective: What you would like to do and future goals

Education: Schools attended and areas of study

Special Skills: What unique skills you have that might be appropriate for the job

Other Activities: What activities have you participated in that will be of importance to the job or enhance your image

For this resume writing activity you should focus primarily on identifying those work experiences that you think will be most useful in the job. The ways in which people usually describe household work is mundane, such as cooking dinner, checking on children's homework, etc. So try to use terms which will present the tasks and skills in a more appealing manner. For example, planning meals and cooking dinner can be translated to read: experienced in dietary planning, culinary arts. What you want to demonstrate in this activity are the multiple roles for which housewives today are responsible, ranging from interior decorator to nurse to child psychologist. Although she is by no means a specialist or expert in all these areas, she has developed experiences and knowledge in them. She is also exposed to a great deal more information than her grandmother. She has contact with current developments and information from magazines, newspapers, consumer information newsletters, books, radio, television, instruction manuals for appliances, adult education courses, and so on. Before mass communication the housewife, or anyone for that matter, had little contact with information outside one's own community. Hence people today are continually updating their knowledge and developing new skills through our various modes of mass communication. Much learning is acquired by variety of different methods made available through technology while technology in turn requires new types of knowledge.

Getting Started: One way to start organizing this particular resume is to list the skills which you think are applicable in the business world, such as:

organizing committees
public speaking
supervising workers
creating new programs
coordinating activities
implementing plans, etc.

Under each of the skills you might then show how you applied these skills by citing the types of activities in which you were engaged. Some might include:

den mother of cub scout pack
library aide
PTA treasurer
Sunday school teacher, etc.

Or, you may wish to list various types of work experiences in the home or in the community and briefly describe your responsibilities.

Budget Management: responsible for budget plan, monthly accounting, bill payments. . .

A SAMPLE RESUME

Rita Pratt
10 Franklin Drive
Brunswick, New Jersey
502-999-1010

PROFESSIONAL OBJECTIVES	To assume an administrative position offering career opportunities in managment, personnel, and/or career planning, utilizing skills of communication, leadership and innovation.
EDUCATION	Associate Degree in Liberal Arts Adult Education Courses: Psychology, Personal Finances, Creative Cooking, Home Decorating
WORK EXPERIENCE	Library Aide (part-time). Organized and supervised pre-school story-time and movie program. Substitute teacher in the Brunswick Township Public School System, grades K-8. Arts and Crafts Instructor — Brunswick Township After-School Enrichment Program. Taught building of hand puppets, instruction in jewelry construction.
	Ability to initiate and coordinate creative programs. Effective skills in leadership and organization in educational and community activities. Demonstrated competence in written and verbal communication skills. Proven ability in enlisting public support and community involvement.
LEADERSHIP/ ORGANIZATION	Area Coordinator for Foreign Student Exchange Program. Interviewed and selected potential host families, planned social and cultural events for students, and was responsible for their well being while in Brunswick Township. Initiated, designed and coordinated all facets of the PTA After-School Enrichment Program for Brunswick Township Elementary Schools. Hired instructors, drafted the curriculum, managed the fees and budget. Chairperson for the Annual Boy Scouts Award Dinner. Responsibilities included allocation of expenses, entertainment, food, site and delegation of responsibilities involving 120 persons.
COMMUNICATION SKILLS	Selected by the Area Scout Leaders to discuss parents' role in scouting on radio talk show. Member of township Historical Association. Used writing ability in preparing guide to local historic sites and newsletter. Moderator at Community Health Fair Day. Ran a panel and supervised speakers on nutrition and health.
PUBLIC SUPPORT/ COMMUNITY INVOLVEMENT	Chairperson of the Helping Hand Program. Community emergency/safety program for local students walking to/from school. Designed window posters and street signs, planned informative school programs for youngsters' safety. Officer in local PTA School Boards. Various executive positions.
REFERENCES	Available upon request.

ROLE PLAYING THE JOB INTERVIEW — Activity 2, Part II

Selecting the Job Candidate

- After you have completed your resume, submit it to the Personnel Department (two or three members of the class will serve as the Personnel Department).
- The Personnel Department will review all the resumes and select three or more. (The number of resumes selected will depend on the amount of time the class wishes to devote to this role play simulation.) The following questions should help guide the selection of resumes.
  - Is the information well presented and interesting?
  - Are the main points made clearly and succinctly?
  - Is it well organized?
  - Does the resume describe a person you want to hire for the job?
  - Have the important accomplishments and skills been presented and what evidence is there to support the statements?

The Interview

- Select a classmate to role play the employer. (The same prospective employer may interview all three candidates, or different students may take turns role playing the prospective employer.)
- The purpose of this interview is to explore in greater detail the ideas summarized in the resume. This provides the job applicant (author of the resume) an opportunity to further explain her competencies. The applicant must now demonstrate the idea that technological advances, while labor saving, create new demands. These new demands frequently require higher level skills that we do not normally associate with managing the home.
- The interviewer's goal is to determine how well the applicant is prepared for the position she seeks. Therefore, the intelligent use of questions is most critical. The interviewer should have a list of questions planned beforehand. This will help guide the interview and insure that the main points of interest are covered.
- Allow approximately 10 minutes for each interview. Since the class already knows the background of the job applicant (described in the role description) it is not necessary to ask questions concerning the applicant's personal background, education, personality or other details of that nature. The interviewer's major goal is to learn more about the work experiences of a housewife. Have her explain some of the experiences listed in the resume. Do not try to make the interview stressful or threatening for the candidate.
- After the interviews are completed the class may wish to discuss or think about some of the following questions.
  - What do you think have been the major effects of technology on the household since 1900?
  - Has technology helped to reduce the amount of work we do? Explain.
  - If a woman from a primitive culture were put in a typical American household, how long do you think it would take for her to learn to become a modern housewife (assuming that there is no language barrier)? What major difficulties might she experience?
  - How well do you think schools help prepare one for the job of household management?
  - More and more women are now working outside the home. What household changes might you predict for the future? What kinds of new technologies would be useful for the working mother?

SCIENCE, TECHNOLOGY AND RESPONSIBILITY

Reading 2:

The Unseen Costs of Nuclear Power And The Faustian Bargain[1]

The Unseen Costs of Nuclear Power

If the technology for using or extracting a resource is new, its application widespread, and the existing social and scientific institutions inadequate for a comprehensive review of potential side effects, both quantifiable and intangible, then the need for foresight can be very great. The example here is the widespread use of nuclear reactors for the generation of electricity in the United States. In 1967, the United States had a few small nuclear generators, totaling 1,000 megawatts of capacity. In April 1973, the United States had thirty operating nuclear generators, totaling 15,500 megawatts. That year, the U.S. Atomic Energy Commission forecast that by the year 2000 the nation would have 1,200,000 megawatts of nuclear generating capacity of which more than 400,000 megawatts would come from liquid metal fast breeder reactors.

The case for nuclear power is a strong one. As of 1973, there were perceived shortages of alternative sources of energy. A shortage of domestic petroleum supplies increased the need to search offshore for oil and build the Alaskan Pipeline, steps involving high environmental risk. The Arabian action to shut off the oil exports to the West revealed the practical extent of U.S. reliance upon foreign reserves. Furthermore, although there was abundant coal in the United States, its use was restricted by the environmental problems of strip mining and the air pollution produced by burning. Against this background, nuclear power seemed to offer an all but inexhaustible supply of clean power for the future.

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[1] Excerpted from *Resources and Decisions*, by the Leonardo Scholars, University of Wisconsin. North Scituate, Mass.: Duxbury Press, 1975.

While the nuclear power stations were planned, purchased, or under construction, and a few were generating power, debate continued about their environmental impact. The main concerns were the amounts of heated water they would return to natural waterways and their radiological safety. John W. Gofman and Arthur R. Tamplin, research associates at the Lawrence Radiation Laboratory, Livermore, California, attracted widespread publicity with their contentions that even minute levels of radioactivity were dangerous. Henry Kendall, of Massachusetts Institute of Technology, and others joined in the questioning of whether the safety systems of generators already constructed could prevent massive releases of radioactivity.

Such arguments, however, were natural science problems, theoretically subject to quantification. They came from natural scientists, biochemists, nuclear physicists, and others, who were dealing with potential "payments" of a tangible nature: if a given level of radioactivity was inadvertently released, then *x* persons would die and *y* dollars of property damage would occur. This was an added cost quite like the payment in lives extracted by the national reliance upon the automobile transportation system. If the numbers had not been filled in yet, it was because there was disagreement over the effects of low level radiation.

But there were intangible costs as well, and while these may have been considered by promotors and developers of nuclear technology for many years, they remained to be clearly identified in laymen's terms and more widely broadcast. It was Alvin Weinberg, director of the Oak Ridge National Laboratory, who finally delivered the message to the public in a speech, later published as an article in *Science* magazine, called "Social Institutions and Nuclear Energy."

The Faustian Bargain

In his article, Weinberg identified an unusual social issue which revealed to some that an increased reliance upon nuclear power might constitute a direct threat to a cherished western value; that is, to traditional concepts of individual freedom. He called it a "Faustian bargain," in which "society" was to pay dearly for an inexhaustible source of power, much like the bargain struck by the legendary Faust, who sold his soul to the Devil in return for temporal influence.

According to Weinberg, the United States, committed today to more than 100 million kilowatts of nuclear power, may be generating electricity at a rate of 1 billion kilowatts by the year 2000. If such projections materialize, the United States will have to isolate about 27,000 megacuries of radioactive wastes which will be generating about 100,000 kilowatts of heat by 2000.

"Of these, the 239 P (Plutonium 239) with a half-life of 24,400 years will be dangerous for perhaps 200,000 years," Weinberg said. (A half-life is the time required for half of the atoms of a radioactive substance to disintegrate.)

Weinberg reviewed the proposed methods for dealing with such wastes, including those of W. Bennett Lewis, of Atomic Energy of Canada, Inc., who has argued that once man commits himself to nuclear power, he commits himself to "essentially perpetual surveillance." Lewis, said Weinberg, favored storing wastes at radioactive operations centers, to be reworked and recycled as emerging technology permits. Weinberg favored putting the wastes "forever out of contact with the biosphere." In this regard, he described the Atomic Energy Commission's activities to develop a large scale disposal in abandoned salt mines in Kansas.

> The great advantage of the salt method . . . is that our commitment to surveillance in the case of salt is minimal. All we have to do is prevent man from intruding, rather than keeping a priesthood that forever reworks the wastes or guards the vaults. And if the civilization should falter, which would mean, among other things, that we abandon nuclear power altogether, we can be almost (but not totally) assured that no harm would befall our recidivist descendants of the distant future.

Thus did Weinberg arrive at his conclusion:

> We nuclear people have made a Faustian bargain with society. On the one hand we offer — in the catalytic nuclear burner (the breeder reactor) — an inexhaustible source of energy . . . But the price that we demand of society for this magical energy source is both a vigilance and a longevity of our social institutions that we are quite unaccustomed to . . .
>
> We make two demands. The first . . . is that we exercise in nuclear technology the very best techniques and that we use people of high expertise and purpose . . . The second demand is less clear, and I hope it may prove to be unnecessary. This is the demand for longevity in human institutions. We have relatively little problem dealing with wastes if we can assume always that there will be intelligent people around to cope with eventualities we have not thought of. If the nuclear parks that I mention are permanent features of our civilization, then we presumably have the social apparatus, and possibly the sites, for dealing with our wastes indefinitely. But even our salt mines may require some small measure of surveillance if only to prevent men in the future from drilling holes in the burial grounds.

Finally, Weinberg asked:

> Is mankind prepared to exert the eternal vigilance needed to ensure proper and safe operation of its nuclear energy system? This admittedly is a significant commitment that we ask of society. What we offer in return, an all but infinite source of relatively cheap and clean energy, seems to me to be well worth the price.

Those familiar with the German legend know that Faust sells his soul to the Devil in return for temporal power and influence. Is this the price "society" must pay for inexhaustible energy? Although he did not say so in his article, Weinberg believes it is not. In a speech at the University of Wisconsin early in 1973, he stated his preference for Goethe's version of the legend in which Goethe had Faust redeemed at last, thereby cheating the Devil.

These are concepts of time seldom before put forward by scientists: Weinberg uses phrases such as "permanent features," "eternal vigilance," "forever out of contact." He is discussing the need for permanence, not only of manmade physical systems, but of social institutions. If Weinberg is asking for social institutions to watch over the dangerous lifespan of only that Plutonium 239 which will have accumulated by the year 2000, such institutions must survive whatever social and natural upheavals occur in the next 200,000 years. Yet man is a species with a written history of, at the outside limit, 7,000 years. In that time, hundreds of governments and other social institutions have appeared and vanished. The longest standing physical features of any size constructed by man are the Egyptian pyramids, which have endured for 4,500 years. One of the most enduring social institutions is the Roman Catholic Church, of nearly 2,000 years' standing.

How do the imperatives of the Faustian bargain relate to the social institutions of the United States?

It is not necessary here to trace the body of law built on the foundations of the Constitution of the United States and the other main source document of the Republic, the Declaration of Independence. These documents embody concepts of individual and social freedom that much of the nation believes to be valid. They set limits beyond which government theoretically may not intrude on individual privacy, mobility, and matters of conscience. Are the issues put forward by Weinberg an extension of or a contradiction to the ideas of those documents?

In some fundamental ways they seem directly opposed. Weinberg speaks of the need for people of high expertise and purpose to be ever present in nuclear technology. He notes that some men in nuclear science speak of "priesthoods," which can be taken to mean an elite corps of high competence and high motivation to provide "eternal" watchfulness over nuclear systems. One can visualize here a world in which all factions continue to compete, often angrily and violently, for the usual reasons, racial, economic, religious, and political — a perpetuation of history so far, but with one major new restraint: the conflict must not touch at any cost, even that of the "due process" concept, the priesthood or other institutions charged with securing radioactive wastes.

Furthermore, it should be remembered that "priesthoods" — that is, elitist, disciplined classes of people who accept as their responsibility the long-range welfare of their constituencies — are corruptible. Cases are not uncommon: quack physicians, scientists who permit their data to be prostituted by narrow interests, clerics who break vows, journalists who avoid controversies, military leaders who inappropriately intrude upon purely political issues, lawyers who commit crimes. No true priesthood has ever existed if invulnerability and incorruptibility are essential characteristics.

Short of achieving human perfection, nuclear priests, over infinite time, will be successful only relatively. *If* the demands of the bargain are absolute and with no provision for failure, then those imperfect priests who fail, fail absolutely. In spite of this possibility and the uncertainties of nuclear safety, Weinberg looks to social forums to provide the extra vigilance needed for safe operation of a nuclear energy system.

Weinberg's bargain is based on the perfection on schedule of the breeder reactor. However, insofar as there were already thirty operating nuclear power plants in the United States in 1973, the imperatives of that bargain were already upon society to some degree. Yet there was little evidence that the social commitments — the longevity of social institutions and whatever degree of priesthood was needed — were understood except by Weinberg and a few others. Certainly not by the general public. The one institution wherein might reside a budding priesthood and source of guidance — the Atomic Energy Commission — was under attack by environmental advocates and others for allegedly failing to meet the first standard of any priesthood, that of regulatory disinterest. Critics often pointed to its dual and seemingly conflicting roles of regulating and promoting nuclear power. Thus, it remained for Weinberg, a nuclear scientist, to identify even abstractly for the public the more crucial issue.

Activity 3: What Other Bargains? Technology, Consequences And Responsibilities

The preceding article discusses Alvin Weinberg's much quoted statement which appeared in the journal *Science*. Dr. Weinberg contends that the application of new technologies calls for new responsibilities and perhaps even changes in the way people behave. The use of nuclear energy has created the dilemma of plutonium storage, which he calls a "Faustian bargain." Plutonium waste which remains radioactive for tens of thousands of years requires safeguards for protecting living things from its lethal radiation. Our society thus has the eternal commitment to insure the safe containment of a highly dangerous substance. This means that the immense responsibility which we have created for ourselves must also be borne by future generations centuries from now. We are passing on a formidable task, and we must question whether or not human society can maintain nuclear safeguards over the long period. Will we need to create new forms of government systems in order to do so? What "price" must we pay for this bountiful source of energy from nuclear power plants?

If nuclear energy generations has created new risks and responsibilities, do other technologies pose such problems? In this activity you consider this question by examining some existing technologies and some of their possible consequences. On Handout 2 are listed six technologies. Next to each technology is an *abuse, misuse,* or *undesirable effect* of that technological application.

Under the appropriate column you will:

1. indicate new responsibilities that confront people because of that technology, and
2. suggest remedies to safeguard people or the environment from those undesirable consequences. That is, what must we *change, learn, give up* or *do* in order to insure a safe and healthy earth for living things?

Describe the types of actions that you feel need to be taken.

1. Will people have to learn to behave differently?
2. What type of new laws or regulations might we need, if any?
3. How can people be trained to act wisely?
4. Are there things that we must be willing to give up?
5. How can we guard against human errors or unwise decisions?
6. How can we reduce the risks to ourselves and future generations?

Procedures

— Your teacher will distribute copies of Handout 2, *Technology, Consequences and Responsibilities.*

— Meet in small groups of 3 to 5 students to complete the handout.

— Examine each of the technologies in turn and discuss how the technology has influenced our lives. That is, what does the technology permit us to do that we could not have done without that technology? From your discussion you should be able to identify some new responsibilities that people now face. List these in the column *New Responsibilities for People.* For example, the manufacturing of automobiles places a responsibility on engineers to design reliable safety features and auto workers to put the parts together with care. Drivers are expected to learn how to operate the car properly, obey traffic rules and maintain the car in good working condition. (Whether people do, in fact, behave responsibly is another question.)

— Under the column *Possible Solutions* suggest a solution for the situation described under *An Undesirable Effect*. The members of the group should agree that the proposed solution is indeed the best solution. Consider the following questions before you arrive at your decision.

- Will it be easy for people to accept the solution? What inconveniences must they learn to accept?
- Does the solution require drastic changes or sacrifices?
- Will the solution be fair to everyone?
- Will the solution restrict personal freedom, and how important is personal freedom compared to the undesirable consequences?
- Will the solution require voluntary action or government regulations? Which is the more desirable and effective solution?
- What effects will the solution have on our existing lifestyle?
- Who will be responsible for carrying out the solution?

— After all groups have completed the Handout, a spokesperson from each group will report on the group's results.

— Following the reports, discuss the questions below.

- Which of the undesirable effects are more difficult to prevent?
- In light of the many benefits of that technology, should people be willing to tolerate the undesirable consequences?
- Were the undesirable effects the direct result of the technology or the consequences of frailties in human nature? Are there ways in which human nature might be improved?
- Could the undesirable effects have been avoided from the beginning?

Activity 3:

TECHNOLOGY, CONSEQUENCES AND RESPONSIBILITIES

Technological Innovation	An Undesirable Effect	New Responsibilities for People	Possible Solutions
Tape Recorders	Illegal copies of tapes are reproduced and sold by "tape pirates"		
Weather modification such as cloud seeding and hurricane control	Hurricanes are diverted from one's own country and sent over another country (perhaps to an unfriendly neighbor?)		
Automobiles	Car exhaust fumes create smog which cause lung diseases and even death		
Computerized Banking	Thieves who discover your bank number draw money out of your account		
Airplanes	Terrorists skyjack airplane for ransom		
Plastics	Production of plastics create toxic waste products that are difficult to safely dispose.		

TECHNOLOGY AND KNOWLEDGE

Activity 4: Can We Preserve Our Existing Judicial System? A Class Debate

In this activity the class will conduct a debate on the following question:

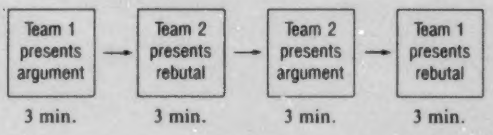
> *DEBATE QUESTION*
>
> ***The jury system should be abolished on cases involving technical questions because the average citizen is not qualified to make decisions on issues requiring highly technical knowledge. Instead, cases should be decided by panels of specialists who have expertise in the areas of the case.***

The class may wish to use a more typical format of debate or follow the procedure suggested below.

Procedure

- Select three members of the class to serve as judges. Or preferably, invite three persons from outside the class.
- Read the two articles, "The Risks of Our Technological Ignorance" and "Trials and Errors" for background information on pages 26 to 27.
- The class will form two teams of equal size: one supporting the statement and the other opposing the statement. Team members will then meet to develop the arguments for its position.
- Each team will first make a list of the major arguments supporting its positions. This list will consist of an abbreviated statement for each argument. Review the list to make sure that all the important arguments have been included and no argument is duplicated. There should be as many arguments as there are team members. If there are too many, eliminate the less important. If there are too few, develop some additional ones. Make two copies and exchange one copy of your team's list for the list from the other team.
- *Preparing for the debate* — Each team member will select an argument from his/her own list to develop into a short two to three minute defense. He/she will also select an argument from the list submitted by the other team and prepare a rebuttal (counter argument), also about two to three minutes in length.

  Each person will thus be responsible for two arguments: one which supports his/her team's position and the other which answers/attacks the other team's argument.
- *The Debate* — One member of the judging panel will serve as the presiding judge. The presiding judge is responsible for conducting an orderly debate and calling upon the debaters in turn. Another judge will serve as time keeper and announce a one minute warning before the three minute limit. The debaters make their presentations in the order as follows:



  The sequence is repeated until all debaters have presented their arguments and rebuttals. A five-minute summation speech is then given by a member from each team. This summation reiterates the most important points made by the team members.
- *Judging the Debate* — A convenient method for judging the debate is to evaluate each set of arguments in turn. After each argument and counter argument is presented, determine which one of the debaters delivered the most effective and convincing argument. Each judge will set up a score sheet similar to that shown below and assign points as follows:

  4 points = excellent
  3 points = good
  2 points = fair
  1 point = poor

  Score Sheet

	Team 1 (Pro)	Team 2 (Con)
Argument 1		
Argument 2		
Argument 3		
Argument 4		
⋮		
Total Points		
- *Some Debate Pointers* —
  - — Skillful debating is skillful communicating. Make sure your argument is clearly stated and well supported by evidence.
  - — Explain why your argument is important. This is best conveyed by presenting examples of possible effects.
  - — Present the argument in a logical sequence, making the most important points first and backing them with sound evidence.
  - — Speak clearly and not too fast so that the audiences can easily follow your ideas.
  - — Be forceful and imaginative. Concentrate on conveying the main issues of your argument.
- *Concluding Observations* — The class debate no doubt raised some new issues and concerns regarding the role of citizens in a highly complex technological society. Some of these ideas are listed below and might be pursued further in a general class discussion.
  - — In a world where scientific and technological information is growing by leaps and bounds, how can the average citizen keep up in order to

understand his/her surroundings? How can one be best educated?

- Can the average citizen have a role in making public policy or should it be left to the experts? If so, how should "experts" be selected?
- Will our democratic system be jeopardized if decision making were left to a small group of experts? That is, will citizens be relinquishing some of their rights?
- Will advance in science and technology require changes in our existing system of government?
- Our Bill of Rights guarantees individuals the right to a fair trial. What should the elements of a fair trial include? Will a trial be fair if the jurors do not fully understand the technical information presented?
- The term "information overload" has been used to describe the increasing amount of information we are exposed to each day through different forms of mass communication, education, other people and personal experiences. Given the limited capacity of our brain, how can we learn to digest and understand all that we encounter?
- What might happen to our society if the common citizen chooses to remain ignorant?

NEXT&LAST

THE RISKS OF OUR TECHNOLOGICAL IGNORANCE

By Joseph F. Coates

Risks in our society are largely derived from technology—directly or indirectly. According to the book, *Technology and Social Shock*, by Ed Lawless of the Midwest Research Institute, a fairly straightforward tally found approximately 1,000 instances of technological gaffes, goofs, blunders, and failures since World War II that were important enough to have made the headlines of the national press. What that amounts to is two significant technological blunders per month—month in, month out—for 35 years. The minimum I can conclude is that there is something amiss in our social management of technology.

Risk management implies conflict, and the government has a great deal of difficulty in dealing with conflict. It also does not have expertise or experience in looking for the side-effects of new technology. Envisioning side-effects requires subtle thinking—something bureaucrats are not noted for. In fact, side-effects are the single most difficult thing for bureaucrats to foresee. Yet, virtually every major disaster we have had has resulted from unforeseen side-effects.

New technology has historically been evaluated by three criteria:

- Can it be done? Is it possible to span this, build that, design the other?
- Will it sell? Or, more recently, will the government pay for it?
- Is it safe to use? Will it pass a vague, "commonsense" standard?

Yet the problems our society faces today rarely result from the failure of those criteria because our problems are side-effect problems. The aluminum cans in Yosemite Park, the thalidomide birth defects, the contamination of a whole year's crop of cranberries by pesticides, air pollution from auto exhaust, toxic seepage from chemical dumps—all are side-effect problems. There is a mismatch between traditional techno-economic planning criteria and what ultimately turns out to be important.

Walter Gurbo

At the same time, there has never been a greater amount of ignorance about the human environment than there is now among middle-class Americans. Ask the ordinary citizen a series of simple questions about our world: What is nylon? Where is the TV picture when it is not in your living room? Where does your sewage go when you flush the toilet? Why do fluorescent lights flicker? See what kinds of answers you get.

Obviously, every new technology generates even greater ignorance. Yet that basic observation is rarely integrated into our planning.

Let me give two examples. First, a minor one: There are about 16,000 women in the United States between 16 and 40 who scuba-dive. It was discovered a few months ago that fetuses are more susceptible to the bends than their mothers. One study found that as a result five of 24 pregnant scuba-divers bore deformed babies. An interesting side-effect problem, isn't it?

For a major example, consider nuclear power, which is a clear case of new technological knowledge generating new ignorance. Harold Green is a George Washington University law professor who has been in the nuclear game for 25 years. He has pointed out repeatedly that the Atomic Energy Commission and its descendants have had the dual responsibility of regulating atomic energy and compaigning for it, too. Being basically technologically oriented, the commissioners naturally framed the regulations to facilitate the development of atomic energy. Thus, atomic energy did not evolve the way other technologies have evolved—small scale, piecemeal, trial and error. It developed in a way that was almost the antithesis of every successful technology that we have in the United States. One result was the accident at Three Mile Island.

A major reason we have been inattentive to such risks is that our middle-class, in their ignorance of technology has delegated the task of overseeing so exclusively to experts. Complexity demands expertise. The expert, of course, must be housed somewhere. That place is called a bureaucracy. We know a number of melancholy and alarming things about bureaucracies: They are conservative; they do not exist to serve the public interest but primarily to preserve themselves. They lie and they shirk responsibility.

How can bureaucracy change its ways? It must begin by recognizing that, to head off undesirable side-effects, a good tactic is prudence. Instead of proceeding full speed with any new technology, let's wait a bit, to mull over any distant warnings. Let's approach risk in an incremental, experimental, trial-and-error way, and thus improve, reinvent, or redesign processes and devices.

To succeed at risk management, the government bureaucracy will need unbiased feedback that is direct, immediate, and continuing on both the effects of new technology and the effects of government action.

The government will also need flexibility. A future that is always changing, a complex future, demands that we be flexible in our responses.

Finally, we need forecasting—an attempt to see in advance the unexpected, undesirable consequences of our current actions—the side-effects, or we shall be in for more and more technological gaffes, goofs, and blunders. ■

Joseph F. Coates, formerly a senior associate at the Congressional Office of Technological Assessment, is president of J.F. Coates, Inc., a policy research organization.

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Reading 4

Trials & Errors: Jury System Guilty Of Shortcomings in Complex Cases

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Selective Use of Judge Alone Or a Blue-Ribbon Panel Gets Increasing Support

Gibberish of MCI vs. AT&T

By DAVID J. BLUM

Staff Reporter of THE WALL STREET JOURNAL

Autovon. Multipoint. FX. CCSA. Brain-twisting terms like these are baffling a Chicago jury right now.

Since early February, seven men and five women have been wrestling with jargon like this in a federal courtroom in downtown Chicago. All the terms are basic to the telecommunications industry. And as such, they have been used with bewildering frequency during the trial of an antitrust suit brought by MCI Communications Corp., a small Washington, D.C.-based telephone service, against American Telephone & Telegraph Co.

A verdict is expected this month. But when it comes, doubts will linger over whether the jury was really competent to judge the case.

Facing More Complex Issues

This problem isn't limited to the Chicago jury. A growing number of lawyers, legal scholars and defendants in civil cases argue that jurors simply lack the knowledge and the background to rule on the complex issues now facing them with increasing regularity.

No one is suggesting tampering with the jury system as it relates to criminal trials. But many of those who defend the present system as the cornerstone of the American judicial process concede the difficulties jurors encounter in some civil cases.

"It borders on cruelty to draft people to sit for long periods, trying to cope with issues largely beyond their grasp," Warren Burger, Chief Justice of the United States, told a conference of chief justices last summer. He estimated that hundreds of lengthy cases fill the court each year.

Studying the Alternatives

Chief Justice Burger has since appointed a committee to study alternatives to the jury system in complex cases. Proposals have ranged from the creation of "blue-ribbon" juries to a constitutional amendment removing the current guarantee of a jury trial for anyone requesting it in a civil case.

Debate over the issue has been rapidly growing, ever since International Business Machines Corp. won an antitrust case two years ago from Memorex Corp. in a San Francisco court. In that case, the jurors voted 9 to 2 in Memorex's favor before declaring themselves deadlocked. But Federal Judge Samuel Conti, after interviewing each juror, went one step further: He declared the jurors ignorant of the facts and handed IBM a directed verdict.

Judge Conti's ruling, along with growing sentiment that antitrust cases go beyond the average juror's ability to understand, has spurred widespread discussion of alternatives. It has also led lawyers, facing lengthy and complicated trials, to consider ways of either using the jury to their advantage or getting rid of it.

Judge or Jury?

"The better your case, the better off you are with a judge," says Nicholas de B. Katzenbach, former U.S. Attorney General and now IBM's general counsel. "The weaker your case, the better off you are with a jury." IBM, the defendant in several antitrust suits, has led the legal fight to strike juries in complex cases.

A snippet of testimony from the MCI-AT&T trial illustrates the problem:

Attorney: "Why were the revenues being placed in jeopardy?"

Witness: "The major reason is, as I said, the breadth of services that we felt—well, for instance, 50% of the market, more than 50% of the market was being foreclosed in the refusal to FX and CCSA interconnect. There are additional parameters. There was the double connection at the double loops of the terminal to the customers' premises under certain circumstances."

Opponents of juries in complex civil cases use jargon-filled testimony like this to argue that as civil cases grow more technical, particularly those in antitrust and patent law, juries aren't capable of deciding them on their legal merits.

Jurors themselves have made the same point. William Westcott, the jury foreman in the IBM-Memorex case, told the judge: "If you can find a jury that's both a computer technican, a lawyer, and economist, knows all about that stuff, yes, I think you could have a qualified jury, but we don't know anything about that."

Many academics also share that view. "On the face of it, a jury would seem totally incapable of understanding these concepts," says Phillip Areeda, professor of law at Harvard University.

One reason for this lack of faith stems from the widely accepted axiom that the longer the trial is expected to last, the less qualified the jury is likely to be.

"People with lesser jobs get on juries in long cases," says Jack Friedenthal, professor of law at Stanford University. "People with the widest experience always get off." Almost no one disputes that assertion—even lawyers who defend a jury's ability to render fair decisions.

That problem showed up in the recent Bert Lance bank-fraud trial in Atlanta, where the jury members who acquitted the former aide to President Carter admitted afterward that the evidence often confused them. None of the jurors had more than a high-school education. A few hadn't even held checking accounts.

Some experts also feel that juries carry considerable bias against big business and thus are more likely to rule on the basis of arguments than facts.

"There's a great deal of paranoia among jurors about big businesses and a willingness to believe that they're involved in all sorts of bad things," says Robert Bork, former U.S. solicitor general and now a professor of law at Yale University. "That's no way to decide a case."

Many, however, still defend the jury as a constitutional right and argue that it should be preserved no matter what the risk. Among the defenders is Hans Zeisel, emeritus professor of law at the University of Chicago and a leading jury scholar, who argues in favor of juries as a "matter of principle."

"The minute you start nibbling away at the jury, you undermine the whole legal process," Prof. Zeisel says. "Perhaps the jury doesn't understand, but isn't it possible the judge doesn't either? Human institutions are frail—better to improve them than to eliminate them."

Blue-Ribbon Panels

But elimination isn't the only possibility offered by jury opponents. Some suggest that a blue-ribbon panel, paid higher salaries (federal jurors normally get $30 a day) and holding qualifications in specific fields, could more properly rule on the kinds of complex issues coming before the courts. But even advocates of that proposal, such as Prof. Bork of Yale, admit that it carries "elitist" overtones.

The jury format at the MCI-AT&T trial offers an alternative solution. The jurors represent a variety of professions, mostly blue-collar. There are a municipal garbage burner and a retired saleswoman, a substitute teacher and an unemployed construction worker. Two have master's degrees, both in library science, but most have only a high-school diploma.

Recognizing their handicaps, Federal Judge John Grady has structured the trial to accommodate some criticisms of the jury system. He has allowed the jurors to scribble notes during the trial, an unusual practice, and to carry glossaries of technical terms. As new words come up, jurors flip quickly through their notebooks for the meanings. Both sides also have prepared elaborate slide shows to explain the meaning of complex testimony.

But while maps, charts and detailed explanations have become a staple of the AT&T-MCI courtroom diet, how well the jurors have digested the information remains an open question—and one that won't ever be answered. When a judge decides a case, jury opponents argue, he must record his reasoning in a published opinion. A juror's decision-making process stays unwritten and private.

IBM and Memorex

IBM has been making that point ever since the 1978 Memorex trial, which had 96 days of testimony spread over six months and included 2,300 exhibits and 19,000 pages of transcripts.

Since that suit, IBM has developed a three-pronged suggested standard it would like to see applied to determine whether a case is too complex for a jury trial. A case would be deemed too technical for a jury if it would last more than 20 to 25 days, if the language of the trial was too confusing or technical, or if the law itself was too complicated—such as antitrust or patent law, which involves complex economic concepts.

"You look at all three and you balance them out," says James Campbell, a Washington attorney and counsel to IBM. "Some are long but not all that complex."

In light of the debate, or perhaps because of it, lawyers and companies involved in complex cases now focus their strategies around the presence of the jury and the changing role it plays as trials grow more complex. Some experts contend that lawyers prey on the jury's weaknesses by applying Perry Mason-like tactics to highly technical issues.

"There's an enormous amount of demagoguery involved" on the part of lawyers, says Prof. Bork of Yale. "Both sides assert facts on the basis of nothing. It's like having a couple of Joe McCarthys in the room."

Kodak and Berkey

Strategy played a major role in an antitrust suit brought by Berkey Photo Co. against Eastman Kodak Co. During the six-month trial in 1978, 100 witnesses were called and 4,000 documents submitted in evidence. The 20,000-page transcript was replete with mind-numbing explanations of market share and photographic processes.

Legal observers who followed the trial suggest that Kodak wanted a jury to decide the case because a jury would be easier to sway than the judge, Marvin Frankel, considered a tough enforcer of antitrust laws. "Kodak thought the jury would think positively toward the company, because so many people use its cameras and film," says Alvin Stein, a New York lawyer who led Berkey's case. Kodak's counsel declined to talk about the case for this story.

Judge Frankel gave the jury 35 yes-or-no questions to consider in reaching a verdict. After eight days, the jury ruled in Berkey's favor. The decision was later overturned by a higher court.

Many feel the debate boils down to a question of whether the right to due process of law will be maintained. "I think the system works pretty well right now," says George Saunders Jr., AT&T's chief attorney in the MCI case. "It comes down to a credibility question: Who's telling the truth?"

Section Two:

EMERGING TECHNOLOGIES

This section introduces some developing new technologies and their possible applications. You will examine how these technologies might affect you and society. As you read through this section think about what society must do to properly manage its technology and what conditions lead to the mismanagement of a technology. Consider also the question of need. Is it truly necessary to develop the technology? Or, when a new discovery is made, do the scientists realize the potential harm that may result? In the discovery of atomic energy, did the scientists ever imagine that the knowledge would be used for building the atomic bomb? In nearly all cases, a new technology raises moral and ethical questions because people hold different interests and values. What is desirable for some people is not considered desirable by others. For example, many people view the computer with fear and suspicion while others consider it to be the greatest development of the century. Because computers have made many jobs obsolete or changed the way work is performed, some people have actually become so frustrated and angry that they devise deliberate schemes to destroy the machine. These differences in opinion create conflicts, many of which are difficult to resolve because there is no single "right" answer.

MIND AND MIND CONTROL RESEARCH

Understanding ourselves has intrigued us as much as understanding the world in which we live. Knowing more about how we function can give us greater control over our lives. The discovery of our body's need for vitamins, for example, has allowed us to prevent diseases such as scurvy, rickets, beriberi, and the like. Thus, to learn more about the workings of the brain is one of the great intrigues of scientific research. The ability of the human brain to think distinguishes us from all other animals and endows us with unsurpassed powers. To further extend that power or treat those who suffer from brain disorders is of course a much sought after goal.

Among the research frontiers in medicine, biology and psychology include studies on expanding human memory, the transfer of learning, altering or controlling behavior, and modifying our senses. Each of these raise certain bioethical questions, questions regarding the right and wrong of particular actions — what actions are more desirable, and what goals should be pursued.

Reading 5

Excerpts from "A Preview of the 'Choose Your Mood' Society"

by Gene Bylinsky

"I finally learned how to come into possession of an encyclopedia. I already own one now — the whole thing contained in three glass vials. Bought them in a science psychedeli. Books are no longer read but eaten, not made of paper but of some informational substance, fully digestible, sugar-coated. I also did a little browsing in a psychem supermarket. Self-service. Arranged on the shelves are beautifully packaged low-calorie opinionates, gullibloons — credibility beans? — abstract extract in antique gallon jugs, and iffies, argumunchies, puritands and dysecstacy chips."

The Polish science-fiction writer Stanislaw Lem wrote the above passage in his book *The Futurological Congress*, published six years ago. Lem's fictitious "psychem" (from psychiatric chemistry) society is a Utopia where whatever people want, they get — helped along by drugs. There are "benignmizers" such as Hedonidol, Euphoril, Inebrium, Felicitine, Ecstasine, and Halcyonal, as well as their antagonists, Furiol, Rabiditine, Dementium, Flagellan, and Juggernol.

Vigilax disperses somnolence, trances, illusions, figments, and nightmares. Obliterine and Amnesol purge the mind of unpleasant memories while Authentium creates synthetic recollections of things that never happened. Duetine doubles a person's consciousness in such a way that "you can hold discussions with yourself."

Optimistizine puts people in the best possible humor. A few drops of Credentium make one person applaud another's every word, while de-hallucinides create an illusion that there is no illusion. Letters with gentle reminders about accounts outstanding and amounts owed are saturated with a volatile substance that awakens the debtor's sense of responsibility and scrupulousness.

Chemical signals of behavior

So fast is drug technology moving along these days that the kind of chemical behavior modification envisioned by Lem is not all that far from becoming reality. "We are on the edge of a choose-your-mood society," says one scientist. "Those of us who work in this field see a developing potential for nearly total control of human emotional status, mental functioning, and will to act."

Just recently, scientists exploring that endlessly complex organ, the brain, have begun to discover chemical signals of specific fractions of behavior. One such chemical enhances visual attention not only in the mentally retarded but also in normal people. Moreover, it promises to increase motivation and improve memory in the elderly. Another newly discovered brain chemical makes people forget unpleasant experiences, just like Lem's Obliterine and Amnesol. A third restores sexual potency.

LSD for generals

Side by side with these discoveries, a separate but closely related area of research is beginning to produce results: the synthesis of new mind- and mood-influencing drugs, chemically akin to LSD, mescaline, and other "mind-opening" agents. In a radical departure from the usual approach to drug design, intended to help people who are identifiably sick, these new drugs promise to help *normal* people in many different ways, from improving their creative capabilities to easing the pain of divorce.

This emerging ability to extend the range of behavior and emotions opens up a very wide range of possibilities. Some time ago, military planners began thinking of mind-altering drugs as weapons of war. When LSD first became available, it was stockpiled by the U.S. Army (and probably other armies) for possible use in disabling enemy forces. Brigadier General J.H. Rothschild, commanding general of the U.S. Army Chemical Corps R. and D. Command wrote following his retirement: ". . . it is easy to foresee that a military commander under the effects of LSD-25 would lose his ability to make logical, rational decisions and issue coherent orders. Group cooperation would fall apart. . . Think of the effect of using this type of material covertly on a higher headquarters of a military unit, or overtly on a large organization!"

Since those early days, even more bizarre and more disabling psychoactive chemicals have been added to military arsenals. The U.S. Army, for instance, has a stockpile of bombs containing BZ, a chemical that causes hallucinations, loss of balance, maniacal behavior, excessive retention of urine, and constipation. One scientist has noted that "the psychochemicals will be the most difficult of all weaponry to control and supervise if disarmament ever comes."

Military applications aside, there are distrubing possibilities of malevolent or misguided use of the new mind drugs to harm or control people. And there will almost certainly be widespread abuse of these drugs. When they become generally known, we will probably see a tremendous demand from a new class of drug users — law-abiding citizens who will want to enhance their creative, sexual, and other potentials.

Stones come to life

Since no mechanism exists for legal introduction and controlled use of these mind medications, they will be illegally manufactured and sold on the black market. The most sought-after of them will undoubtedly command very high prices. "The real problems in the field of psycho-pharmaceuticals," says Nathan S. Kline, a pioneer in that field, "are not so much the creation of new classes of drugs, but determining who shall make the decisions as to when they should be used, on whom, and by whom."

These unresolved questions have taken on a certain urgency, because, whether we like it or not, the capability of synthesizing highly specific mood- and mind-influencing drugs is already here. Experience with psychedelic drugs hints at the possibilities. The effects of psychodelics include drastic changes in perception. Sounds are transformed into visual sensations, each tone or noise producing a kaleidoscopic color picture. Objects such as flowers or stones appear to pulsate and come to life. Incredible scenes are imagined. Incidents from the past are relived. Time and space are transcended. Many users also claim that their artistic perceptions — appreciation of paintings and music — are enhanced.

But no one has produced any artistic masterpieces under the influence of hallucinogens, and while they are not physically addictive, the drugs often have adverse side effects. A sense of unease, even panic, sometimes grips users of LSD and mescaline. In some cases, anxiety or visual aberrations have persisted for days after use.

Now investigators are pursuing in their laboratories the question of how derivatives of the powerful mind-influencing drugs can be made to work for the benefit of man without damaging hallucinations or harmful side effects. In doing so, investigators are working with a new understanding of the brain.

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The applications of the new mind drugs so far constitute just a small beginning, a mere prologue, but already some scientists working in the field are troubled by the lack of adequate social mechanisms for making the new drugs available. "There is no social, scientific, or medical apparatus for optimizing normal human behavior," [Arnold] Mandell [co-chairman of the psychiatry department at the University of California at San Diego and a pioneer tester of new drugs] observes. "I think it will take decades, because there is no aegis in our society for introduction of performance- or life-improving drugs. Under whose aegis could we administer a creativity drug, for instance?"

Some scientists question whether there is any need for mind-influencing drugs for healthy, normal people. [David] De Wied [a Dutch pharmachologist], for instance, feels that the major aim of psychopharmacology should be to help the sick and the infirm aged. But it does not seem at all likely that drugs capable of improving people's moods or enhancing their powers without serious side effects can be confined to the sick and the infirm aged.

The specter is here to stay

"This field," says Joel Elkes, a pioneer biochemical psychiatrist, "poses the ethical dilemma of science at its most poignant. The specter of a drug-polluted or drugged society is here to stay, until faced responsibly through a process of education and gradual permeation by an enlightened regulatory process."

Such, then, is the momentous and difficult challenge presented by the new "choose your mood" medications. The need to do something about them will be upon us sooner than almost anyone suspects. Unless we are prepared to deal with them as a society, the lack of a mechanism for carefully dispensing them may create social stresses that will make the mind-drug "revolution" we've already gone through seem like a minor aberration by comparison.

END

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Reading 6

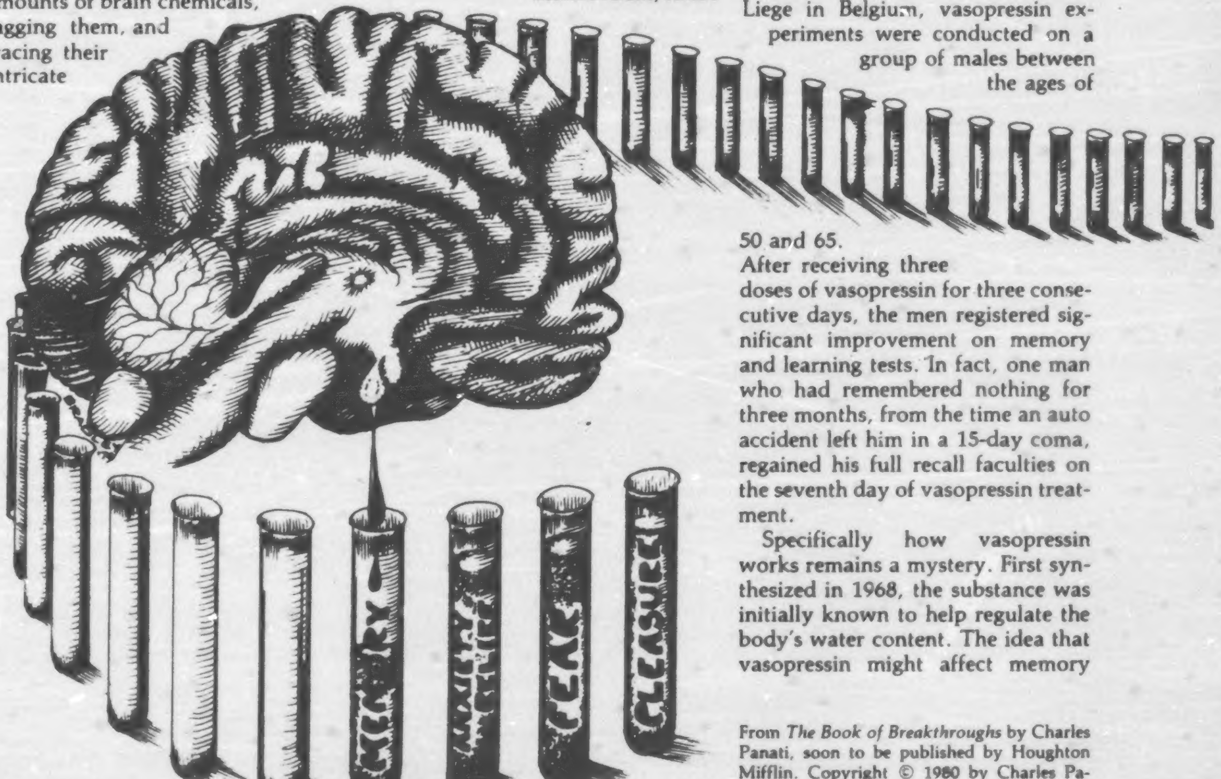
Brain Breakthroughs:

YOUR BODY'S OWN DRUGS FOR PLEASURE AND PAIN

by Charles Panati

The day may be near when people will sniff a nasal spray to improve their memories, pop a pill to calm irrational phobias, or take super painkillers without fear of addiction. Research going on in biomedical labs throughout the world may achieve these and many other breakthroughs within the next two decades.

Fifty years ago, Sigmund Freud predicted that every mental event would one day be traced to chemical reactions in the brain. Today, scientists are proving him right. Not that their 1960s analogy of the brain as a complex computer is wrong, but scientists are learning that a more fundamental and fruitful approach to understanding the brain's functions is to view it as a giant chemistry set. For the first time, scientists are measuring minuscule amounts of brain chemicals, tagging them, and tracing their intricate pathways. Memory, concentration, fear—even aggression—have all recently been identified as chemical events. This fresh insight into the brain promises to yield major breakthroughs during the next two decades in the treatment of mental illness and the alleviation of pain. It also offers the possibility of increased creative ability. Here are several advances we can expect.



Researchers are discovering that chemicals in the brain may be responsible for a whole range of human actions and emotions.
Illustration: Bradley Sanders

A Nasal Spray to Enhance Memory

Forgotten where you parked your car? Can't remember where you left your best dress to be altered? Sniff vasopressin and you'll remember.

Vasopressin is a hormone located in the cherry-sized pituitary gland, at the base of the brain. Scientists working with vasopressin have found that a few whiffs of the chemical can stimulate memory, even in the severest cases of amnesia and senility. What's more, the results are lasting. Vasopressin must be inhaled rather than taken orally because it is a member of the peptide family of organic compounds, which decompose in the digestive tract.

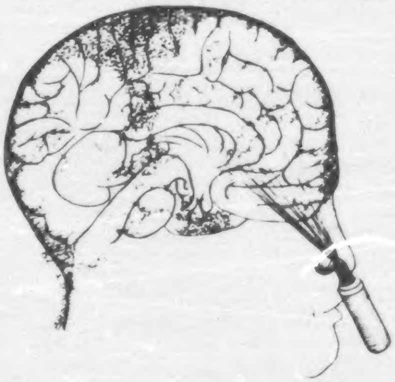
Recently, at the University of Liege in Belgium, vasopressin experiments were conducted on a group of males between the ages of 50 and 65. After receiving three doses of vasopressin for three consecutive days, the men registered significant improvement on memory and learning tests. In fact, one man who had remembered nothing for three months, from the time an auto accident left him in a 15-day coma, regained his full recall faculties on the seventh day of vasopressin treatment.

Specifically how vasopressin works remains a mystery. First synthesized in 1968, the substance was initially known to help regulate the body's water content. The idea that vasopressin might affect memory

From *The Book of Breakthroughs* by Charles Panati, soon to be published by Houghton Mifflin. Copyright © 1980 by Charles Panati.

was proposed by D. de Wied, a Dutch scientist at the University of Utrecht. De Wied discovered that by removing the pituitary gland in rats he could impair their memory and interfere with their learning ability. Identification of the hormone, and follow-up work with more rats, confirmed the link between vasopressin and memory: rats that sniffed vasopressin not only learned faster, but better remembered the paths through intricate mazes.

Vasopressin does produce mild side effects; namely, more rapid heartbeat and higher blood pressure, both of which can be potential problems, particularly for the elderly. But researchers assert that any undesirable effects may be eliminated without reducing vasopressin's effectiveness if the drug is administered in very small doses over longer periods of time. Sandoz, the company that synthesized the chemical, predicts it could market a completely safe version of vasopressin by 1985.



Vasopressin, a hormone located in the pituitary gland of the human brain, can improve people's memory when inhaled, even in cases of severe amnesia.

Illustration: Bradley Sanders

Thus far the hormone has been tested only on short-term memory—the ability to recall events of the recent past. But tests are underway to determine if vasopressin can also activate childhood memories, or possibly even help a person regain the facility with a foreign language learned earlier in life. Since vasopressin has already been prescribed in the treatment of diabetes, rigorous testing on people to document its effects on long-term memory should not take long. For the moment, though, vasopressin will be used primarily to treat amnesia victims. But in the near future, vasopressin may help you sharpen your memory and enhance your learning ability. The regular use of vasopressin may even sustain your brain's memory mechanism so that you could be spared the forgetfulness that usually accompanies old age.

Increasing Your Attention Span

The degree to which you can concentrate on a task may make the difference between success or failure. Some of us seem to be plagued by frustratingly short attention spans, which cause us to be easily distracted. If that's the problem, a shot of ACTH/MSH may offer a solution.

Amphetamines, the popular pep pills, speed up the mind, but they don't give it focused direction. There is, however, a natural brain protein that does both. It's present in two hormones located in the pituitary gland. One of these chemicals, ACTH (adrenocorticotropic hormone), is known to stimulate the secretion of sex hormones; the other, MSH (melanocyte-stimulating hormone), regulates the amount of dark brown pigment (melanin) in your skin. This "sex-tanning" compound may prove to be a chemical wonder.

In 1971, studies on rats showed that the ACTH/MSH protein improved memory. More recently, work by endocrinologist Abba Kastin of the Tulane University School of Medicine reveals that the protein produces a dual effect in people: it improves visual retention and heightens their powers of concentration. Students injected with the compound were better able to remember geometrical figures flashed before them, as well as to concentrate more effectively on their studies, and for longer periods of time. When the students' concentration was tested by a series of monotonous, repetitious tasks, those who received the brain protein scored higher than those injected with a placebo. It's possible that if you're one of those fortunate people who can concentrate despite the most tempting distractions, your body may naturally produce a generous amount of ACTH/MSH.

Perhaps the most significant discovery concerning ACTH/MSH is that it appears to be the only significant drug for the mentally retarded. Retarded patients given injections of the protein have been able to comprehend tasks more rapidly and demonstrate clearer thinking. This fact may indicate that some forms of retardation are caused by lack of a "concentration" compound. Also, Kastin has begun testing his hypothesis that ACTH/MSH may be effective in treating senile patients and hyperactive children. Certain forms of learning disabilities and senility may prove to be due to nothing more than the loss or congenital lack of sufficient amounts of the concentration hormone.

Relief from Anxiety and Aggression

Is aggressive behavior programmed into our genes? Sociobiologists answer yes, behavioralists, no. The definite answer may not be decided for many years, but in the meantime, neurobiologists are clearly demonstrating that aggression has a chemical basis—and that violent behavior can be controlled by a balance of the brain's own chemicals.

Messages are routed through the brain by neurotransmitters—the chemicals that relay information from one nerve cell to another. (Until a few years ago, scientists thought that only a few major neurotransmitters existed. Today, however, they count over 30 and suspect dozens more will be discovered.) In 1978, in the first study of its kind with people, scientists at the National Institute of Mental Health (NIMH) found that human aggression appears to be regulated by two neurotransmitters, serotonin and norepinephrine. The tests were conducted by Frederick Goodwin of the NIMH on a group of navy enlisted men who had difficulty adjusting to military life. Through his research, Goodwin learned that those men with more serotonin in their spinal fluid scored lowest on aggression tests, but those with more norepinephrine scored highest. Goodwin's tests confirmed what earlier animal studies had suggested: a link between the two chemicals and aggressive behavior.

Goodwin and other scientists be-

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lieve that any chemical controlling violent behavior works by suppressing either our primitive "reptilian" brain, which governs ritualistic and hierarchical aspects of life, or the more recently evolved limbic brain, which governs our emotions and altruistic feelings. Antianxiety drugs, which have been administered time and again to dozens of species of animals, have invariably produced calming effects, and there is growing evidence that behavior-controlling drugs operate primarily on those sections of the human brain that evolved earliest.

Goodwin believes, however, that the neurotransmitter-aggression link isn't necessarily genetic. "One's environment, particularly early life experiences," he says, "can have an influence on biochemical balance." This may mean that a child repeatedly confronted with situations arousing aggressive behavior may learn to produce high levels of norepinephrine and low levels of serotonin—a pattern that remains throughout his life. According to Goodwin, there is a chemical available to correct the neurotransmitter imbalance. Lithium, which boosts serotonin levels in animals and makes them docile, has produced beneficial effects in recent tests on aggressive prisoners. Ethical issues, says Goodwin, are the only considerations that prevent immediate application of his findings.

About the Author

Charles Panati has taught physics at Columbia University, was head physicist at RCA in the field of space communications, and for six years was a science editor for *Newsweek* magazine. His previous books include *Supersenses* (1974), *The Geller Papers* (editor, 1976), and a novel, *Links* (1978). In *The Book of Breakthroughs*, Panati paints an optimistic picture of the future in which life will be made easier and healthier through coming advances in medicine, science, and technology. He can be reached c/o Curtis Brown, Ltd., 575 Madison Avenue, New York, New York 10022.

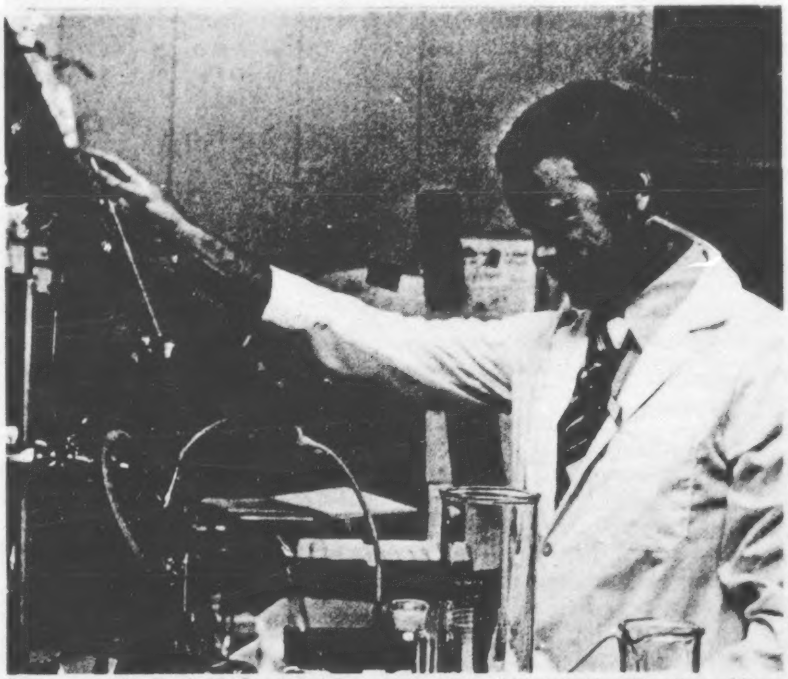


Photo: National Institute of Mental Health

Brain researcher Frederick Goodwin takes a measurement in his National Institute of Mental Health laboratory. In tests on a group of navy enlisted men, Goodwin and a team of researchers found that men who scored higher on aggression tests had a higher than average level of a specific neurotransmitter in their spinal fluid. Certain chemicals, such as lithium, seem to moderate neurotransmitter imbalances and may prove an effective treatment for a variety of mental disorders.

A Pill for Your Fears

Are you afraid of heights, enclosures, strangers? Each of these fears, and other bothersome anxieties, may originate from specific molecules in the body. If these molecules could be chemically identified, your particular phobia could be cured by a drug.

Animal studies point to the possible existence of behavioral brain molecules. One such molecule may be a fear peptide, a tiny string of 15 amino acids. In controversial tests, scientists at Houston's Baylor University College of Medicine and the University of Tennessee trained rats to fear the dark before killing them to extract various chemicals from their brains. One extract, every time it was injected into the brains of untrained rats, caused the animals to experience intense fear of the dark for a week. The scientists named this brain protein scotophobin, meaning "fear of the dark." What surprised them even more than the rats' reaction was their subsequent observation that when modified rat scotophobin was injected into goldfish, the fish stayed in the open during daylight hours. The goldfish wouldn't even venture into the shadow of a rock for food!

The results of the scotophobin experiments have been doubted by many scientists who claim that this research does not prove that learned behavior can be so neatly contained in a chemical and then transferred from one creature to another. But in 1978, German scientists, working with honey bees, demonstrated that at least another type of learned behavior, "time sense," appears to reside in a molecule and can be transmitted from one bee to another. At Wurzburg's Zoologisches Institut, scientists trained bees to feed from a bowl of sugar water at a set time each day. Brain tissue from these insects was then surgically inserted into spaces on both sides of the brains of other bees. For two days the recipients showed no special feeding pattern. But on the third day—and for only that one day—60% of the bees suddenly fed at exactly the donors' preferred time. The scientists found no evidence that nerve connections had formed between graft and brain, and concluded that the donor bees' learned time sense was most likely chemically transferred to the recipients, and that the messages were probably too weak to dominate the recipients' behavior for more than a short time.

Neuroscientists have reason to believe that the chemicals governing such animal "emotions" as fear, loyalty, and hostility may not be substantially different from those chemicals yet to be isolated in people. Some time within the next two decades a chemical model of the brain should provide the first clear explanation for the spectrum of human emotions. In the meantime, we can be both smugly pleased and profoundly disappointed that such emotions as joy, love, aggression, and fear are firmly rooted in the chemical soil of the brain. The fact may make us seem less human, but at the same time more wondrous in design. In addition, this discovery promises to yield some of the most effective treatments ever for mental disorders.

Photo: National Institute of Mental Health

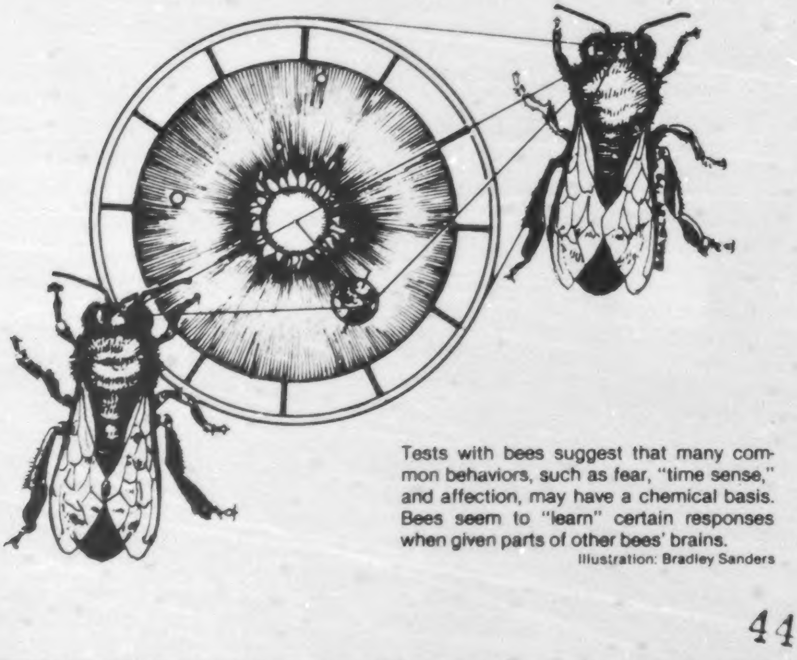
Researcher Michael Murphy and members of a new strain of hamster examine a cutaway model of the human brain. At the National Institute of Mental Health's animal farm, Murphy is using the hamsters to study the neurological processes involved in the social behavior of animals.

R_x for Schizophrenia

Schizophrenia is one of the most baffling of human states. Although psychiatrists disagree on its cause and treatment, there is mounting evidence that most, if not all, schizophrenia has a chemical basis. The biochemical theory most widely accepted today assumes that the symptoms of schizophrenia—disturbed thinking, perceptual distortions, paranoia, and withdrawal—result from having too much of the brain chemical dopamine and not enough of several other neurotransmitters: primarily acetylcholine (which the body manufactures from the choline in lecithin-rich foods), and the sleep-triggering hormone serotonin (which the body produces from the amino acid tryptophan, found in meats and dairy products). This theory has sparked several researchers to consider the role of diet in treating schizophrenia—as well as other kinds of mental illness. This is not a popular theory in psychiatric circles, but since several studies are in progress the theory is sure to make news, one way or another, during the 1980s.

A more solid clue in solving the schizophrenia puzzle comes from the fact that researchers have detected abnormally large amounts of the naturally occurring brain proteins called endorphins in the spinal fluid of acutely disturbed schizophrenics. Endorphins (for "endogenous morphine") are short strings of protein belonging to the peptide family of chemicals. They are structured like plant morphine molecules, and when extracted from the brain of animals and administered as a drug they display amazing painkilling properties.

Stanford University's Stanley Watson has found that the heroin antagonist naloxone, a chemical known to block the action of endorphins in the brain, has alleviated the auditory hallucinations in severely impaired schizophrenics. Patients besieged by imaginary voices are relieved by comforting silence for up to two days on naloxone. What has confounded scientists is that a closely related brain protein, beta-endorphin, seems occasionally to cure schizophrenia. Psychiatrist Na-



Tests with bees suggest that many common behaviors, such as fear, "time sense," and affection, may have a chemical basis. Bees seem to "learn" certain responses when given parts of other bees' brains.

Illustration: Bradley Sanders

than Kline, director of the Rockland Research Institute in Orangeburg, New York, found that several chronic schizophrenics recovered and continued to improve more than 10 months after their last beta-endorphin injection. One patient, a man who had been totally helpless for 15 years, is now self-reliant. "There is very little doubt at the moment," says Kline, "that, for whatever reason, beta-endorphin is effective." The primary drawback to immediate treatment is its expense. A single injection of beta-endorphin costs $3,000. Kline is certain, though, that the cost will soon decrease. If similar studies confirm his observations, Kline asserts that clinical treatment of schizophrenia with beta-endorphin could be available by 1983.

Can the blood affect schizophrenia? Robert Cade, director of renal medicine at the University of Florida, has been putting diagnosed schizophrenics through six-hour blood-cleansing sessions as though they were being treated for kidney failure. He claims that more than half of the patients he has dialyzed since he began the treatment in 1972 "have either gotten well or improved enough to leave the hospital and go to work."

In 1978, Cade finally amassed evidence of why blood cleansing alleviates schizophrenic symptoms. The blood of his patients had contained an unusual brain protein called leucine endorphin in concentrations 10 to 100 times higher than normal. Each dialysis treatment removed more of the protein, and after the eighth week of treatment the leucine endorphin level had been reduced to a normal quantity. Cade's early success was considered suspect by most of his colleagues, but since the isolation of leucine endorphin several other researchers have tried dialysis—some with significant results. At the moment the evidence on dialysis is conflicting, and NIMH psychiatrists are investigating the technique. It may turn out that the causes of schizophrenia are varied: some patients might be helped by diet, others by drugs or dialysis. Or a combination of the three. One of mankind's oldest and most complex mental illnesses may be cured in our lifetime.

No More Cold Turkey

The brain's own proteins may provide the first testable theory—and the first innocuous cure—for drug addiction.

Enkephalins (based on the Greek for "in the head") are naturally occurring brain proteins. They differ from endorphins in that they are smaller protein chains, but like their chemical cousins they play a major role in the formation of emotions and perception of pain. It was in attempting to explain why morphine, a plant opiate, is such a powerful analgesic that researchers in 1975 first discovered enkephalins and endorphins. Thus, it's not surprising that the proteins may provide a cure for addiction.

Dialysis of the blood may someday be a common treatment for schizophrenia.
Illustration: Bradley Sanders

Solomon Snyder, a Johns Hopkins University scientist, has reason to believe that the dependence on an opiate like heroin (which structurally resembles the brain's own opiates) reduces the body's production of enkephalins. Therefore, greater quantities of heroin are needed as addiction continues, since the heroin must replace the missing enkephalins. The agony of withdrawal occurs because it takes the body time to resume its own production of enkephalins once heroin is stopped.

Several hospitals are testing Snyder's hypothesis. Some researchers radioactively tag heroin in order to chart its activity in the brain. Others are tracing the pathways of fluorescent-stained enkephalins. They hope to design a drug that temporarily compensates for the enkephalin deficit when an addict goes cold turkey, thus preventing the agony of withdrawal. Several new synthetic enkephalinlike drugs offer that possibility, but the trick is designing one that is itself nonaddictive. Computer drug design techniques hold out the promise that by the end of the 1980s such a nonaddicting drug will be available.

The Perfect Painkiller

A powerful, nonaddictive analgesic thousands of times more potent than morphine may be an early practical spin-off from modern brain research. Laboratories in Hungary, Switzerland, England, and the United States are competing to be first to market the super painkiller—expected to be developed by 1985.

Chemically, the brain's natural opiates are dissimilar to morphine, which is an alkaloid—one of about 25 that together constitute opium. Enkephalins, on the other hand, are pentapeptides—molecules containing five amino acids (or simply a protein). In terms of geometrical structure, however, morphine and enkephalins both fit snugly into the same receptors in the brain. So when enkephalins were discovered in 1975, researchers immediately set out to develop their use as a perfect painkiller.

Of all the enkephalins they injected directly into the brains of hospitalized patients, they learned that only one, the C-fragment, acted as a powerful painkiller; it is in fact 100 times more potent than morphine. But a painkiller that must be injected into the brain is impractical. Enkephalins given intravenously provide only minor and very temporary pain relief because the brain's own protective enzymes quickly destroy foreign enkephalins as they try to pass from the blood stream into the brain.

As a result, researchers decided to design synthetic enkephalins to resist the attack of brain enzymes, and their efforts have begun to pay off. In 1976, Candace Pert of the Johns Hopkins University School of Medicine developed a synthetic enkephalin that offered profound, long-lasting relief when injected into rats. The following year Kastin at

Tulane University discovered a synthetic enkephalin that relieved pain in rats for a period 30 times longer than natural enkephalins. Now drug companies have entered the field and are spending millions of dollars tinkering with amino-acid chains to find the perfect painkiller.

Scientists in Budapest have substituted two tiny amino acids into an enkephalin chain and come up with a chemical that, when injected into the human brain, has 1,500 times the painkilling power of natural enkephalins. At Sandoz, Inc., in Switzerland, scientists have constructed an enkephalin analog that is 30,000 times more powerful than the brain's own version. What's most promising (and highly unusual) is that it retains its analgesic quality when taken orally, which had not been thought possible because peptides normally are digested before they can enter the blood stream and make their way to the brain. Unfortunately, Sandoz's present version of the super painkiller is mildly addictive. Yet Swedish scientists feel that within a few years they will produce an addictive-free version of the drug. Presently, opiates like morphine are unrivaled in dulling the severe pain that accompanies surgery, burns, and malignancies. In a few years' time, however, these plant opiates, which can lead to addiction, may become obsolete.

The Ultimate Trip

The perfect painkiller may also become a peerless pleasure pill, the "in" drug of the 1980s and 1990s. Development of the former will undoubtedly spawn an underground market for the latter.

If a super synthetic enkephalin can alleviate pain, it should, theoretically, also induce blissful euphoria. Morphine, after all, plays both roles—and it and enkephalins act on the same nerves in the brain. The goal of brain researchers is not to produce a super psychedelic, yet it already appears to be an offshoot of pain research. To test the pleasure potential of enkephalins, researchers at Wyeth Laboratories in Philadelphia implanted small tubes into the brains of rats. By pressing levers, the animals could freely tap solutions of enkephalins, morphine, and a neutral fluid. The rats opted for the enkephalins as often as for morphine, and seldom for the neutral shot. Enkephalins, the researchers concluded, induce pleasure similar to that of morphine.

The perfect painkiller ought not to be physiologically addictive, but as a potent mood elevator it could easily hook people psychologically. Drug-control authorities have fought against heroin-trafficking for over a hundred years; the black-marketing of the "peerless pleaser" could turn into the drug-control nightmare of the next century.

Fits of Pleasure

The great novelist Fyodor Dostoevsky experienced extraordinary euphoria prior to his epileptic seizures. Other epileptics have reported similar feelings. The pleasure-inducing ability of enkephalins may soon provide doctors with a biochemical explanation for epilepsy, and an original, highly effective treatment for the ailment.

In 1972, an epileptic submitted himself to electrical stimulation of the part of his brain called the amygdala. He was not cured, but he did experience opiumlike intoxication lasting for hours. This response mystified his doctors. Six years later, neurologists discovered that the amygdala is rich in enkephalins, and they immediately posed the question: Do high concentrations of enkephalins produce epileptic seizures? In 1978, scientists at the University of California School of Medicine in San Francisco found the answer by injecting enkephalins into different areas of the brains of rats. In the rats' midbrain, enkephalins acted as painkillers; in the forebrain, they induced epileptic fits. It appears that epilepsy may result from tiny proteins that have wandered from their home base. Scientists suggest the possibility of developing a drug that would suppress enkephalin migration, or production in the forebrain, and this could become the preferred treatment for epilepsy.

Creative Drugs

Deep into a novel, a writer is plagued by a mental block. A composer has written a brilliant first movement but can't shake cliches from the adagio. A million-dollar slogan eludes the ad executive. What they all share is a need for insight, which they may receive from the creative drugs of the 1990s.

Aldous Huxley believed that hallucinogenic drugs could enhance creativity and fresh ideas if only they didn't distort perception so strongly. Arnold Mandell, a psychiatrist at the University of San Diego, and Alexander Shuglin, a pharmacologist, are tinkering with hallucinogens to design a drug with precisely the properties Huxley dreamed of. Their findings are still tenuous, however, because testing new drugs on people must progress slowly. A psychiatrist at the University of Chile, Claudio Naranjo, has experimented with a few of Mandell's drugs on students and found that their thinking and emotions are heightened without perceptual distortion. One compound, developed from linking mescaline to a popular amphetamine, seems to produce neither euphoria nor speeding, but a sense of newness or novelty in a familiar situation. Another compound, made from manipulating a common antidepressant drug, not only relieves depression, but also creates feelings of high motivation. This experimental compound is being tested on mental patients and stands a good chance of becoming a commercial antidepressant.

Still, no pill can be expected to turn a dullard into a genius, or generate motivation where there is no underlying ambition. But if a person's creative instincts are blocked or have temporarily turned stale, he could receive a fresh boost from these psychotropic drugs. Mandell feels that for the most part performance-enhancing drugs will be illegally synthesized, tested behind closed doors, and sold on the black market, perhaps by 1990. When will doctors be able to prescribe a creativity pill? "It will take decades," Mandell predicts. "There is no aegis in our society for introduction of performance or life-improving drugs. Under whose aegis, for instance, could we administer a creativity drug?" ❧

DILEMMA 1:
Perfecting Human Nature?

June Nelson, a lab technician, while searching through her director's desk for the data of their last experiment, comes across a diagram that jolts her senses. She cannot believe what she sees! The diagram shows the main water reservoirs of the state, and indicated on each are dilution factors. June puts two and two together and recognizes this as the plan to release into the state's water supply the new drug they are developing.

The drug that she and Dr. Sue Randall have been working on for the past ten years is a brain altering chemical. They are now close to perfecting the formula. The chemical drug acts on the aggression centers of the brain, and very small amounts will permanently inactivate a person's aggression-controlling brain cells. As a result, people will not longer act angrily or violently. They will be unable to harm other people or things. If this drug were given to everyone, the entire society would be gentle and docile. This may end the need for prisons and even wars.

However, the plan to put the drug in the state's water supply and altering everyone's behavior frightens June. She has no idea how society may change if everyone were no longer aggressive. Will they lose their motivation and ambition? Will they let other people take advantage of them? Will they be unable to defend themselves from attack by animals or insects or other dangers?

June feels she should report this to the authorities. They will no doubt close the lab immediately and, of course, arrest Dr. Randall. This would mean that their long ten years of work will be lost. The benefits of the drug will never be realized. If she reports this she will also be betraying her friend and superior.

Should June report her discovery? Why or why not?

DISCUSSION QUESTIONS

- Should it be June's responsibility to speak out? Why or why not?
- Does a person ever have a right to change human nature even if he/she thinks he/she will improve upon it? Explain your reasons.
- Should people have the right to decide whether or not they want their minds altered? Why or why not? What might result if some people were aggressive and some non-aggressive?
- Should the scientist attempt to develop such a drug? Who should decide what scientists can or cannot work on?
- What are some of the benefits of a non-aggressive world? Disadvantages?
- What responsibilities does a scientist have to society when he/she develops a mind altering drug?
- What controls should the public have over scientific studies? Is it their responsibility?
- If the drug were perfected and made available for public use (rather than put into the water supply), who will decide who can or cannot use the drug? Should aggressive prisoners, for example, be forced to take the drug against their will?
- Should it be important for people to maintain their total brain capacity, including the capacity for negative behavior? Why or why not?
- What responsibilities does she have to her superior and the advancement of science.
- An aggression altering drug could be one of the most powerful weapons of warfare. Would it be right for a country to use such a weapon?
- Should Dr. Randall discontinue her research if she thought that her work would be used in warfare? How does this situation compare to the scientist who worked on the development of the atomic bomb?

ENERGY TECHNOLOGIES — ELECTRICITY FROM THE SUN

The quest for new energy sources to meet our ever increasing energy needs has become all the more urgent in recent years. Oil prices have skyrocketed, and oil reserves are rapidly dwindling. Coal is abundant, but the burning of coal creates major pollution problems. Nuclear power, once thought to be our ultimate answer, has generated new economic, ecological and political problems. The use of firewood for heat and cooking has denuded mountains and leveled forests. Hence, technologies to harness the bountiful rays of the sun, that will not run out for the next 10 billion years nor produce pollutants, have become an important priority. While solar home heating is a relatively simple technology, conversion and storage of solar energy in the form of electricity presents some complex and challenging problems.

In the case of centralized solar power plants, high technologies are involved. This brings up the question of large centralized versus decentralized solar power. If in the future we plan to rely on solar energy to produce our electricity, we must make certain decisions about the types of solar power plants we construct. Will our solar power plants be centralized or decentralized?

A centralized system means large power plants supplying power to a large population. This is the system that currently exists in the U.S., requiring high technologies, high purity materials, costly manufacturing processes and a complex delivery network. Any failure or breakdown in the system can suddenly incapacitate a city, as evidenced in the two blackouts in the New York City area in the past few years. Also, finding appropriate sites to locate the large power station is another problem. Solar collectors to provide electricity for a large city may cover several hundred acres of land and need to be located in places where the sun shines brightly each day. Deserts are, of course, the ideal spot, but few cities are located nearby. So, the electricity produced may have to be transported over hundreds of miles of wires, a costly distribution network.

Decentralized solar power, on the other hand, is producing energy on a small scale to supply local needs such as a small community, an office building or one's own home. It will require changes in the way we currently obtain our energy. It may mean using a variety of energy producing systems. Homes may use on-site solar technologies for heating, and redesign or retrofit of the structure is necessary. Back-up heating systems will be required for days when clouds block the sun. On those days will we use wood stoves? Will we generate our own electricity? Or, will we buy electricity from power companies? How can power companies be prepared to meet a sudden surge in electricity demand? Will they be able to serve the occasional customer?

The development of new solar technologies raises a series of new questions. Some of these questions will be considered in the following readings and discussion.

Reading 7

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Solar Satellite Passes Bee Tests, but Others Await

By Arlen J. Large
Staff Reporter of The Wall Street Journal

At the behest of the federal government, a number of unwitting bees have been zapped with microwaves by scientists in California. The bees then were set loose, and the men of science watched to see if the insects had trouble finding their hives.

Very few did. And that apparently removes one more obstacle from the path of the super-ambitious project that envisages solar-power satellites providing electricity for the 21st Century.

Solar cells on the giant satellites would produce electricity, which would be beamed back to earth in the form of microwaves, which would be turned back into electricity and sold to utilities to power light bulbs, toasters and hair dryers.

That's where the bees come in. The government is supposed to investigate every conceivable victim of such a huge technological venture. The government believed it was possible that bees flying around within a few miles of a microwave receiving station could become disoriented by radiation and might neglect their essential job of pollinating food crops.

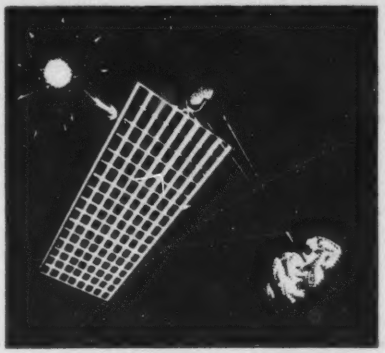
Assessing the Risks

And there are many other possible side effects from what one critic says could be "the largest single investment in the history of civilization." Mainly to assess them, the government has spent $20 million on a three-year study that is just winding up.

The study, done jointly by the Energy Department and the National Aeronautics and Space Administration, has come up with a rather inconclusive, open-ended answer. While a final report hasn't been released, the agencies are expected to say that they haven't found any insurmountable obstacles to proceeding with solar-power satellite technology.

"The bee problem could have been a stopper," says Frederick Koomanoff, the Energy Department official in charge of the study.

Just because the Energy Department found no scientific "stoppers," however, doesn't mean a commitment to put solar-power satellites on the launch pad is imminent. In fact, the project's backers—including a big rooting section in Congress and an organized group of aerospace companies—feel considerably frustrated.



Last January, the Carter administration included in its budget for the fiscal year starting next month a dab of money to keep the project's door open. But the allocation was removed in Mr. Carter's balance-the-budget binge in March, and Congress hasn't restored it.

A decision on whether to accelerate research mightn't be made until the fall of 1981. By then, studies by the National Academy of Sciences and Congress's Office of Technology Assessment will be completed.

What happens next naturally depends on who is writing the budgets in the coming four years. The Sunsat Energy Council, comprised of a dozen high-technology corporations plus individual space buffs trying to promote solar-power satellites, has solicited the views of the 1980 presidential candidates.

The idea has "great potential," replied an aide to Republican nominee Ronald Reagan, without signing any pledges. The "platform" of independent candidate John Anderson specifically calls for "continuation and amplification" of research.

"An Utter Disgrace"

But the Sunsat Council hasn't heard anything from the Carter campaign. That is "an utter and absolute disgrace," says Frederick Osborn, executive secretary of the group.

Government caution about any early commitment stems from the project's fantastic cost. To have something specific to talk about, the Energy Department and NASA worked up a "reference system" describing a possible solar-power satellite project. There would be 60 satellites, each six miles long and three miles wide (the dimensions don't quite fit, but everybody compares the size to that of Manhattan Island).

Each satellite's parts would be fired 22,500 miles into space by a new generation of rockets. Up there, thousands of space workers would assemble the parts over a period of 30 years early in the next century. Together, the satellites would beam 300,000 kilowatts to their receiving antennas on Earth for delivery to utilities.

Critics say that would be just 20% of projected U.S. electricity needs, but proponents say the share would be more. The official projected cost: $830 billion. Some say that by the time cost overruns and maintenance are counted in, the tag would approach $1 trillion.

People Get Upset

The "reference system" gives the proposal's enemies something specific to shoot at, even though the ultimate design could change. The Sunsat Council's Mr. Osborn says it is reasonable for the government to have drawn up a specific plan for discussion. "But it creates great problems in a public-relations sense," he adds. "When you talk about satellites as big as Manhattan, people get very upset and you can't talk to them any more."

The approaching completion of the government's preliminary study has spawned a formal opposition group that hopes to prevent further work.

"We've come far enough to see that the economics preclude further R&D investment," says Scott Denman, spokesman for the new Coalition Against Satellite Power Systems. The group represents solar-energy enthusiasts who are ideologically drawn to decentralized, rooftop collectors, rather than government-subsidized power sold by giant utilities.

Astronomers also have lodged complaints about sunlight glinting from 60 power satellites, making each as bright as the planet Venus and spoiling the darkness of the night sky. Mr. Osborn of the Sunsat Council contends the actual satellites can be designed to minimize reflectivity of light.

Reading 8

Solar Power System

Preliminary Societal Assessment

by Charles Bloomquist, Alan Daurio, Stephen Shotland

HCP/R4024-01/14

Introduction

The continually increasing rate of national energy consumption (far greater than the rate of population increase) and growing reliance on dwindling stocks of fossil fuels sustaining an energy-intensive, pollution promoting, technologically-based economy has led to an increasingly intense demand for new, less polluting renewable or inexhaustible sources of energy. One concept that may, at least partially, satisfy this demand beyond the year 2000 is the Satellite Power System (SPS) first proposed by Dr. Peter Glaser of A.D. Little Inc. in 1968.

The SPS is a new approach to providing base-load electrical power on Earth. Studies to date have generally concluded that the SPS concept is technically possible. However, the decision to proceed with SPS will not be based on strictly technical grounds. It will depend on a political determination that the commitment of economic, institutional, and social energies required for implementation of the SPS concept is a worthwhile investment. This determination will be national (and probably international) in scope and will be based upon increased knowledge of the environmental and social impacts of the SPS, its projected economics and technological risks, expressed through the influence of contending segments of society.

Analysis Of Relevant Issues

To assist the decision-maker, an assessment of societal issues associated with SPS has been included in the SPS program being directed by the SPS Project Office. By June 1980, the SPS Concept Development and Evaluation Program is to have developed "an initial understanding of the economic practicality and the social and environmental acceptability of the SPS concept ... It must be realized that this effort is very unlikely to achieve a firm recommendation to implement the SPS concept. Rather, if no insurmountable barriers are found, one should expect recommendations as to the direction of the SPS program after Fiscal Year 1980 toward further laboratory experimentation and field testing ... One the other hand, a recommendation, based on identification of a major barrier, might be to discontinue further research and development."

The primary societal assessment objectives are: (1) to determine if any of the social ramifications of an SPS might significantly impede its development, and (2) to establish an information base regarding these issues to be used in the comparative assessment. The approach taken to meet these objectives is "mainly oriented to serving decision-making needs. The traditional research standards of analytic perceptiveness and precision, data completeness and reliability, and depth of causal understanding apply only insofar as they serve the purposes of policy selection, design, and administration."

The four major areas of the societal assessment are (1) resources; (2) institutional issues; (3) international issues; and (4) social impacts. Experts were assigned to prepare reports for eleven specific issues associated with these four study areas. In general, the reports are intended to provide a baseline state of knowledge for each issue, identify and define important problems, make recommendations for further investigation and outline ways to solve problems.

Resource Requirements

Based on an initial understanding of system characteristics, physical resource requirements are expected to be greatest for materials, land and energy. The SPS Reference System offers two solar cell options, depending on the material used in the cells -- silicon or gallium arsenide. Thus, material requirements will differ somewhat between each design option. Problems arise in the demand for mercury and tungsten in both options and silver and gallium for the gallium option. These four materials represent about one-fifth of the primary materials needed by the SPS and are either potentially or definitely in critically short supply. In addition, manufacturing capacity problems are judged to be more severe for the gallium option.

SPS energy ratios have been found to be marginally favorable with respect to other energy sources when the system boundaries have been drawn so as to exclude fuel ("fuel" in this case being solar radiation). When fuel is included, the SPS energy ratios are very favorable. There are, however, large uncertainties associated with the SPS design and with the energy analysis techniques themselves. Accounting for indirect energies in the analysis is acknowledged to be a significant problem. Further, the high initial energy investments of a capital-intensive SPS program make for a long pay-off period; high initial energy requirements create a protracted energy drain during the initial years of operation.

> Siting data will also influence estimates of land acquisition costs; placement of rectennas with respect to existing utility grids and load centers; relocation of industries and populations; and the extent of local socio-economic impacts.

Three geographic categories exclude U.S. land areas from consideration for potential rectenna site eligibility. These include (a) dedicated land uses; (b) climatic and environmental conditions; and (c) physical or biological constraints and important natural resources. Applying these criteria to the continental U.S. shows that (a) the greatest number of eligible areas occur in the West North Central and West South Central states and in Nevada; (b) the fewest eligible areas occur in the Northeast, South Atlantic, and East North Central states; and (c) eligible areas are scattered in the Pacific, and East South Central states. Consequently, a problem arises in matching potentially-eligible areas to power demand areas. At this point in the analysis, it is impossible to assess whether offshore sites are needed; DOE researchers have recommended that sea sites

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be included in any further assessment of the rectenna siting issue.

Population displacement would be minimal at rural sites but relocation of industries and attendant economic effects could be substantial. In developed regions, rectenna sites would cause substantial population displacement but minimal relocation impacts.

Institutional Issues

Institutional issues are: (1) identification of organizational options for managing the SPS, (2) development of alternative financing schemes, and (3) policies and regulations governing implementation and operation. At this point in time, it is difficult to say whether existing institutions are adequate to deal with the unique features of the SPS.

In lieu of the federal government's establishment of a national energy policy, many states are going their own way, creating a de facto decentralized trend in energy policy. States want and are asserting increasing control over power plant planning. This poses a potential problem for the SPS because the states are placing emphasis on decentralized power sources. As has happened in the realm of nuclear energy policy, state and local policies may conflict with federal government policies on the SPS, with state and local regulations generally being more restrictive.

> Public interest groups have greatest access at the state and local levels. Therefore, the potential for dealing with public concerns may be greater at these levels of government, especially after the land use analysis narrows down the possible locations of rectenna sites.

The inherent characteristics of the SPS as a centralized power source will require regional coordination of power plant regulation and transmission interties. However, no present regulatory framework exists at interstate levels. And while at the present time, siting regulations affecting rectenna placement are not as extensive outside the U.S., it is to be expected that differences in regulatory practices between the U.S. and other industrial countries (e.g. Japan and Western Europe) will decrease with time due to growing concern with environmental issues in these countries.

> Alternative financing schemes deemed most feasible will be those for which federal, private sector, and foreign controls are at levels acceptable to the public.

The large capital requirements for SPS through R&D and the initial operational phases tend to favor some form of public sector financing. R&D financing may simply be too large for the private sector to assume. The federal government or a consortium of governments may be the only available source of financing during start-up operations. Even when the SPS reached maturity, the private sector would face an extreme challenge to finance the program. A joint venture partnership between government and the private sector is possible. The public interest can be assured under the arrangement by regulation of prices and profits, and government license of the technology.

Cash flow requirements and rate of return on investments, major determinants of a private sector role, are most affected by the busbar cost of electricity. Consequently, some governmental guarantee of delivered power costs may be required. Other financial inducements or government subsidies may also be necessary to encourage private sector financing.

International Acceptance

Three issues of importance to the SPS deal with (1) controls expected to be exercised by international organizations through enforcement of treaties governing operations in space, and new agreements (e.g. on microwave radiation, geostationary orbit and radio frequency assignments) that may be required because of unique aspects of the SPS; (2) international organizational options to successfully manage the SPS; (3) military implications of the SPS.

An international organization is strongly indicated for SPS development and commercialization. TVA and COMSAT/INTELSAT are good organizational models for the way in which external relationships would be handled (e.g. voting power in INTELSAT is exercised on the basis of financial participation--shared ownership). Any SPS organization must be (a) responsive to U.S. energy need; (b) politically feasible; (c) cost-effective; and (d) conducive to international cooperation and acceptability. The COMSAT/INTELSAT option meets these four conditions. The international scope of the SPS, however, may be better obtained by selling SPS hardware (i.e. satellites, rectennas, etc.) rather than the power because foreign participants would have a greater stake in the venture than if they were merely passive consumers.

> Reaching international agreements on microwave radiation safety standards, microwave frequency and geosynchronous orbit slot assignments will take time. Negotiations between governments will determine the character of whatever consortium may be devised to manage the program and may lead to new treaties governing the operations of SPS.

Extensive treaty provisions would be required in order to realize an internationally acceptable SPS. In the case of the SPS, the consideration of space and its environs as part of the "common heritage of mankind" raises the question as to who should benefit from the space resource. The seemingly finite geostationary orbit space and increasing competition for its use will influence slot availability for the SPS. It may be anticipated that, ultimately, a world body will have authority regarding both geostationary orbital slot and radio frequency allocation.

On the subject of harm caused by orbiting space objects, a country that launches a SPS satellite would appear to be internationally liable for harm produced by microwave radiation emanating from a space object in geostationary orbit. International law prohibits adverse changes in the environment. There is a present lack of knowledge about microwave health and environmental effects.

The huge power supply that the SPS would develop and the strategic position of the geostationary orbit make the system attractive for military application and also vulnerable to attack. Thus, militarily, the SPS becomes a factor in international relations. Since the outer space regime has been recognized as an international resource in several treaties, military use of the SPS, even to protect itself, may have an adverse impact on the relations of the U.S. with other nations. An SPS which has, or is thought to have, some military capability could make the attainment of treaties governing its operation more difficult.

> The SPS's potential as an offensive or defensive component of the U.S. military could de-stabilize international relations and make it an attractive target for hostile action on the ground or in space. Public response to proposals that the SPS be militarized could significantly affect the outcome of the project.

Most of the investigators dealing with international issues note that the U.S. could take a positive role in calling for an international pool of resources to help in assessing the feasibility, benefits, and impediments of developing a satellite power system. Consequently, they have emphasized the need for an early and continuing dialogue on the SPS with interested foreign groups.

Social Impacts

The issue of centralization of power is an important topic for investigation on the basis that (a) there may be a dichotomy between design concept and public expectations which see solar power as being decentralized and controlled by individuals, not giant utilities; and (b) the magnitude of the power output relative to present power-generation facilities may have potentially wide sociological ramifications. Two corollary issues concern public acceptance and the demographic and economic consequences attending potential relocation of industries and populations to and from rectenna sites.

The relocation of industries and population due to SPS implementation is dependent upon choice of site and the cost of electrical transmission among other factors. Industries most likely to relocate to rectenna site regions are those which consume a significant amount of electricity and have an uncertain energy supply future such as iron & steel, chemicals, paper, and aluminum. It is likely that a "boomtown" phenomena would occur at SPS rectenna sites, growth-induced effects at these sites through population in-migration following industrial relocation are predictable.

> Estimates of the degree of societal adjustment which would follow from implementation of the SPS program would add substance to the public discussion of the advantages or disadvantages of power centralization. The issue of centralization is related to the larger issue of how technology is transforming the structure of human society. The role that the centralization of energy generation might play should not be overlooked in understanding the broader social implications of the SPS.

At the same time that "boomtown" phenomena have occurred, there has developed a general shift away from centralizing tendencies in the U.S. A militant new regionalism is likely to emerge in the next decade. Conflicts over energy and environmental issues are increasingly perceived as regional conflicts. The SPS, consequently, may have to meet regional energy needs if no single national energy policy exists at the time of its introduction.

There is also a trend for the U.S. to consider "appropriate scale" for technological innovations, rather than an emphasis on "economics of scale". Thus, the development of a national awareness of the possible environmental impacts of large-scale (and private) projects; passage of various laws and regulations for the purpose of controlling environmental degradation and mandatory direct public involvement in project review and approval and the rise to prominence of public interest organizations among other factors, has made the consideration of public acceptability of the SPS very important.

Positive response towards the SPS has been based on the view that SPS could become a possible solution to the energy crisis, an application of solar energy to meet baseload energy needs, and a general economic restorative. There is also a perception that the SPS will be a "cleaner" energy source than alternative energy systems. On the other hand, there are major concerns with the SPS; these include microwave effects on health safety & the environment; launch vehicle emission effects; and land use/rectenna siting. Other concerns include microwave communications effects; internationalization; and centralization effects.

Therefore, as a first step in alleviating public concerns and encouraging general participation in the SPS program, it is desirable to identify and establish a dialogue with important segments of the populace. The goals of student and public participation programs should be to create a flexible participation structure for direct involvement of the public in the SPS program development. Internationally, public acceptance may be less important than governmental concerns especially if an initially U.S. SPS organization moves towards international status.

For Further Study

This preliminary phase of the Societal Assessment was conducted over a period of about three months. Given the state of knowledge of all aspects of the SPS concept, it is not surprising that further research is required to identify and evaluate the societal issues associated with the proposed energy system. No prohibitive or insurmountable societal barriers have been identified which would constitute "program stoppers". However, there are some key questions that remain to be answered. These include the following:

-- Do suitable areas exist for rectenna sites that are well-placed with respect to energy demand centers?

-- Can the U.S. utility system projected to exist in the "normal" course of events be expected to accomodate the SPS?

-- Is there a suitable organizational structure which will be suitable most of the time, to various levels of government, the general public, the business world, and the international community?

-- Can the SPS capital requirements be met without seriously inhibiting other necessary investment?

-- Can international agreements be forged that will permit SPS operation?

Other questions, such as those dealing with resource availability (e.g. materials and energy) await further refinement of the reference system concept. Public concerns can be eliminated only through further environmental studies (of microwave bio-effects, for example) and by placing the SPS within a broader energy perspective.

Reading 9

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The Irradiated Consumer

Have you added up the rems you received today? With cancer on the increase, consult our guide.

Mark Miller, T. A. Vonder Haar, and Judith Miller

You are being stalked by radiation, whether it is naturally occurring or man-made. If you think you escape behind the closed doors of your home, think again. Your eyeglasses, microwave oven, smoke detector, glow-in-the-dark watch, CB radio, color television, kitchen range, drinking water, dinnerware, false teeth, and certain other household items may be irradiating you.

Sources of radiation exist outside your home also. There follows a primer of radiation sources a consumer commonly encounters, how much each emits, how much radiation the federal standard says they can give off, and what is known about their health effects.

Radiation is generally divided into two types: nonionizing and ionizing. Nonionizing is weaker. It jostles electrons orbiting atoms but does not tear electrons away from atoms. Examples of nonionizing radiation are radio waves, microwaves, infrared, visible, and all but the shortest ultraviolet light. Ionizing radiation is strong enough to disrupt atoms by knocking off electrons, thus converting the atom to an ion. Examples of ionizing radiation are short ultraviolet rays, X-rays, and gamma rays.

Ionizing radiation damages cell or genetic material. It was believed that, other than heating tissues, nonionizing radiation posed no biologic risk. Today, a controversy is developing over that issue.

Radiation is measured in units called roentgens, rads, or rems. For our purposes, one roentgen equals one rad, which equals one rem. One-thousandth of a rem or rad is called a millirem (mrem) or millirad (mrad).

The federal government has established standards for how much radiation one can "safely" be exposed to. For workers, the standard is 5 rems (5000 mrems) per year; for the general public, the standard is 0.5 rems (500 mrems) per year.

Dr. Edward Radford, chairman of a National Academy of Sciences committee, recommended a tenfold reduction in the amount allowed workers. Since the public is allowed 10 percent of the radiation allowed a worker, the new standard, if enacted, would allow a worker 500 mrems a year, and the public 50 mrems.

According to Radford, the risk of cancer increases 0.5 to 1.0 percent for each increase of one rem.

I

Natural Background Radiation. Before man ushered in the atomic age, he was exposed to radiation emitted by natural objects or phenomena called *background* radiation. The total background dose every individual receives every year is 100 mrems. Dr. John Goffman, professor emeritus of medical physics at the University of California, Berkeley, has estimated that each year, natural radiation kills 19,000 Americans from cancer and leukemia, and 588,000 from genetic defects such as heart disease and diabetes.

Medical/Dental X-rays. Even though you get over 90 percent of your ionizing radiation from medical/dental diagnostic and therapeutic procedures, the radiation you receive by these means (on the average of 60 mrad per American per year) is not part of the federal standard of 500 mrems you are allowed to receive each year. Dr. Karl Morgan, former head of health physics at Oak Ridge National Laboratory, wants medical radiation included in the standard. Morgan claims that superfluous medical radiation may be causing 3,500 to 36,000 unnecessary cancer and birth-defect mortalities annually in America.

A recent Food and Drug Administration investigation found that more than 130 million Americans are subjected to at least one X-ray each year. Properly done, X-rays produce health benefits, but risks must be reduced. Primary sources of unnecessary risks, according to Dr. Sidney Wolfe of the Health Research Group, are X-rays "that shouldn't be done at all or ones that were done with poorly functioning equipment, poor techniques, and/or inadequate patient protection."

The FDA has found that one-third of X-ray examinations are unnecessary, and are done as a result of poor judgment by the doctor or dentist, for legal protection or monetary gain.

Federal regulations require that no X-ray machine manufactured after August 1, 1974, can leak more than 100 mrems in one hour measured one meter from the apparatus. Nevertheless, a subsequent FDA investigation found that 30 percent of new X-ray equipment emits too much. Although they checked only a small sample of older machines, they also seemed to leak too much.

One FDA document notes that cutting down the number of X-rays given to pregnant women "would avoid approximately ninety cases of childhood cancer annually."

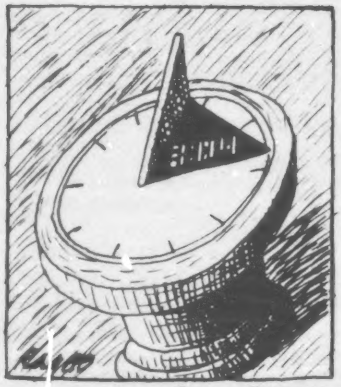
Some doctors, dentists, and X-ray technologists are using faulty techniques. They set the X-ray level too high, unnecessarily repeat 10 percent of X-rays they perform; 50 percent of the time the X-ray beam is larger than the area of film it is to expose. In addition, they do 90 percent of X-rays without shielding organs adjacent to those being X-rayed. Only New York, New Jersey, Kentucky, and California require X-ray technologists to have certification in the proper use of X-ray equipment and only the California State Board Examination asks questions about the adverse health effects of X-rays.

Timepieces. If you check the time by glancing at your glow-in-the-dark wristwatch, pocketwatch, or clock, or your electronic digital wristwatch, you may have been irradiated, however slightly.

The radioactive element in radioluminescent timepieces is tritium, promethium, or radium, which emits the most penetrating radiation. Since 1972 only a few radium watches have been sold. Tritium, and to a lesser extent, promethium, replaced radium in watches, although radium is still employed on clock dials and other luminous instruments.

The FDA estimates that if you have one of the 8.4 million radium clocks, the maximum dose you get is 0.6 mrems per year. If you are one of the ten million persons wearing a radium wristwatch, the National Council on Radiation Protection estimates that, on the average, it radiates your gonads with 3 mrems every year.

A July 1975 report published by the FDA's Bureau of Radiological Health found that there were two million tritium watches in 1973 whose radiation, if shared equally across the entire population, would come to 0.17 mrems per American per year.



Digital Timepiece

The situation regarding electronic digital watches is more complicated. Digital watches that give a readout on demand by pressing a button are *not* radioactive; of those that give a continuous readout, only certain types manufactured since February 1976 use a radioactive element. Tritium gas is the radioactive component, and it escapes the timepiece at a rate of less than 0.5 mrem per year.

According to the FDA: "The conclusions thus are obvious: Radium should not be used for dial painting because tritium can be used to accomplish the same results with substantially less exposure to the user."

Smoke Detector

Smoke Detectors. In 1976, five million smoke detectors were installed; twenty-nine state building codes require smoke detectors, and the National Safety Council has come out in favor of their use. Smoke detectors have an obvious benefit—an early warning system in case of fire, and it is possible to buy a smoke detector free of any radioactive risk. Chances are nine to one against your having bought the risk-free kind, however, for, according to the National Bureau of Standards, only one million of the nine million are the risk-free *photoelectric* type, which uses a light beam to detect smoke. The predominant seller is the *ionization* type, which employs a radioactive element: americium or radium.

The purported advantage of the radioactive kind is that it responds to both smokeless and smokey fires whereas the photoelectric type is only set off by the latter. However, a study by Underwriters Laboratories and the Illinois Institute of Technology shows no apparent difference in life-saving potential between the two types. This led to a call for the ban of the radioactive type by the Health Research Group, in view of the fact that recent improvements in the photoelectric type have brought their ability to detect fires up to that of the radioactive units.

And what happens in a fire? Will the unit leak radioactivity? Theoretically, it is not supposed to; but in England government tests found that some detectors built by one company leaked excessive radiation at temperatures of a house fire. It seems advisable, therefore, for consumers to get a smoke detector, but to choose the photoelectric types.

Television. Television sets have the potential for generating X-rays capable of escaping from the cabinet or picture tube. Black and white sets produce X-rays too weak to penetrate the glass of the screen, so they emit no radiation. Color sets produce a more penetrating X-ray. Color sets made between 1950 and 1970 may give off X-rays. By 1967, 15 million color televisions had been sold in the United States, and sales were increasing at the rate of 4.5 million a year.

A federal standard was put into effect January 15, 1970. It stated that color televisions manufactured after that date could not give off radiation exceeding 0.5 mrems per hour measured at a distance 2 inches from the surface of the set.

The law did not apply to sets made prior to January 15, 1970. So, if your set was made after the law went into effect, it complies with standards the federal government considers "safe." According to the National Council on Radiation Protection, "a home survey of 1124 color receivers in the Washington, D.C., area during 1967-1968 showed that . . . 6 percent exhibited rates that were above the NCRP recommendations" (the NCRP recommended value became the 1970 federal standard). For a typical viewer watching color television the average number of hours, and whose set meets federal emission standards, his or her reproductive organs absorb 4.3 to 17.2 mrems a year.

Eyeglasses. Tinted eyeglasses can be a source of radiation. The radioactivity is due to thorium and uranium, which occur as natural impurities in the rare earth, and zirconium compounds used to manufacture lenses. The Nuclear Regulatory Commission permits such glass to contain up to 0.25 percent uranium plus thorium by weight; however, a 1975 study found cases where thorium exceeded the standard by as much as a factor of 10.

Tests on eyeglasses whose thorium content was in compliance with the federal standard and which were worn sixteen hours a day found that the eye received a dose of approximately 1000 mrems per year, twice the dose recommended by the National Council on Radiation Protection. As a result, in 1975, the Optical Manufacturers Association put into effect a voluntary radiologic standard for eyeglass lenses.

False Teeth. Over 19 million Americans wear full dentures and 60 million wear crowns. Some 90 million have at least one false tooth. Half of all dental prostheses contain porcelain, the balance contain acrylic plastics.

The porcelains but not the acrylics are radioactive. Why? For cosmetic reasons: "For over half a century, the manufacturers of artificial teeth have added uranium salts to porcelain in an attempt to match coloring and fluorescence of natural teeth under lighting conditions," explains the Environmental Protection Agency.

The Nuclear Regulatory Commission does not allow porcelain teeth to contain more than 0.05 percent uranium by weight.

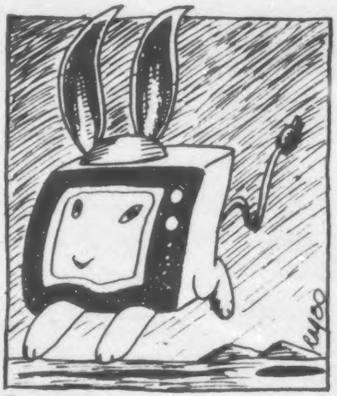
Porcelain false teeth can irradiate at amounts beyond the level of background radiation. According to the EPA, "although the radiation dose from the amount of uranium presently used in artificial teeth does not create a significant health hazard, the dental industry has been urged by the EPA's Bureau of Radiological Health to find a nonradioactive substitute within a reasonable period of time. Until a practical substitute for uranium becomes available, the EPA has recommended a maximum permissible concentration of uranium in dental porcelain of 0.037 percent. This would reduce the probability that the dose from artificial teeth might exceed the 1500 mrem per year set by the International Commission on Radiation Protection."

II

Nonionizing radiation enters our environment to as great an extent as ionizing radiation does. Environmentalists call it "electronic smog." Theoretically, nonionizing radiation is too weak to tear electrons away from atoms as ionizing radiation does; rather, the nonionizing type merely excites electrons and increases the vibration and rotation of atoms and molecules. The only apparent effect is an increase in temperature. Nevertheless, research conducted over two decades in the Soviet Union and in recent years in America has begun to question the safety of nonionizing radiation.

While there is a small level of nonionizing radiation from the sun and stars, the "natural background," the amount given off by man-made creations is 100 to 200 million times greater. The list of man-made sources is endless: radio and television stations, microwave ovens, citizen-band radios, burglar alarms, shoplifting-detection devices, beepers, industrial heating and drying equipment, radar, ultraviolet lamps, lasers, and so forth.

Nonionizing radiation is mea-



TELEVISION

An Ohio woman wearing a pacemaker alleged that she became dizzy when a neighbor three blocks away broadcast over his CB.

sured in terms of microwatts or milliwatts hitting a square centimeter surface. A microwatt is one-millionth of a watt; a milliwatt is one-thousandth of a watt; a watt is a unit used to measure electromagnetic power such as electricity.

The level of disagreement among experts as to what constitutes a "safe" level of nonionizing radiation is shown by the fact that the United States currently has no standard for the public, while Russians are allowed exposure to only one microwatt; moreover, while Russian workers can receive only ten microwatts, American workers are permitted 10,000 microwatts (10 milliwatts). The discrepancy exists because American scientists generally have not accepted the findings of Soviet scientists that a multitude of adverse health effects are caused by chronic exposure to low levels of nonionizing radiation.

According to the Soviets, long-term exposure to low-level microwaves and radiowaves might cause headache, irritability, emotional instability, depression, tension, pains in the chest, eyes and head, crying, loss of appetite, indigestion, dizziness, fatigue, diminished intellectual abilities, loss of memory, decreased sexual abilities, both insomnia and sleepiness, leukemia, cataracts, heart trouble, high or low blood pressure, loss of hair, trembling, immune-system alterations, genetic damage, and so forth.

TINTED EYEGLASSES

The following are major nonionizing radiation sources in your home and neighborhood.

Radio and Television Broadcasting. There are 350 UHF television stations, 600 VHF television stations, 3,400 FM radio stations, and 4,400 AM radio stations in the United States; there are tens of thousands of navigation and weather radars and hundreds of thousands of microwave communication towers. As soon as you set foot out of your house these sources become the main contributors to the radiation you receive. To a degree they also penetrate the confines of your home or workplace.

The EPA, in October 1975, began a program to measure levels of emissions. Measurements were taken at seventy-two sites in Atlanta, Boston, Miami, and Philadelphia. The population of these metropolitan areas is 8.3 million. "The results to date (September 1977)," the EPA concluded, "suggest that probably 99 percent of the urban population is exposed at levels which would be permitted even under the restrictive proposed Soviet standard of one microwatt."

These findings were encouraging. By February 1978, the EPA had completed measurements in eleven metropolitan areas, and planned to complete other measurements in Denver, Los Angeles, San Francisco, and Seattle.

The EPA added one note of caution, however: "Measurements show that power density levels in some areas of the upper floors of tall buildings can be much higher than the measurements made at ground level. At windows facing transmitters, with blinds raised, the maximum levels observed in selected buildings in New York, Miami, and Chicago were 32, 97, and 66 microwatts, respectively, and consisted primarily of radiation from FM radio and UHF television transmitters." Such levels can be significantly reduced by the use of certain "structural materials and window blinds," the EPA suggests.

A reading of 66 microwatts occurred on the fiftieth floor of the Sears Tower in Chicago; the 97 reading was on the thirty-eighth floor of a Miami office building; and a reading above 30 was detected on the fifty-fourth floor of the Pan Am Building in New York City. Urban measurements exceeding the Soviet standard occurred near radio and television towers. For example, a reading of 10 microwatts was taken near an FM tower in Las Vegas; and one of 3.5 in the vicinity of a Washington, D.C., UHF television tower. If only one percent of Americans are getting doses above the Soviet standard, that would be two million of us.

CB Radios. Approximately fifteen million citizens-band radios are beaming shortwave communication among homes, cars, trucks, and vans. Not only are they great fun, but they are recommended so you can call for help from your vehicle without having to leave it. The trouble is that many CBs broadcast at strengths that far exceed the standard of 10,000 microwatts.

Whenever you drive past a vehicle with its CB in use, you get dosed. If the vehicle is a police car, ambulance, or taxi, the dose is even higher since such vehicles house radios emitting hundreds of thousands of microwatts. Other factors that attract larger doses are the metal loop on your steering wheel, and any bridge having metal grids if you're near the transmitting vehicle as you both go under it.

In June 1978, the Associated Press reported three instances that came to the attention of the Federal Communications Commission, where a person claimed that another's CB caused unnecessary and potentially dangerous triggering of a heart pacemaker. In one case, an Ohio woman wearing a pacemaker alleged that she became dizzy and had to be given oxygen when a neighbor three blocks away broadcast over his CB. The woman filed suit against the neighbor, who denied his CB was to blame. But since cardiologists do not agree on whether CBs can affect the operation of pacemakers, the federal government is studying the matter.

Microwave Ovens. In 1975, sales of microwave ovens surpassed sales of gas ranges; 800,000 were sold. Today they are one of the hottest-selling consumer products. The convenience is unbeatable. They will cook a three-pound chicken in four minutes or a hamburger in seconds.

Because of their tendency to leak, the FDA established a federal standard applicable to ovens manufactured after October 6, 1971. According to the standard, no microwave may emit more than 1,000 microwatts at a distance two inches from its surface before it is sold. After the purchase, the standard rises to 5,000 microwatts.

Since most radiation leaks out through the door and door seals, the standard requires the manufacturer to build safety interlocks that prevent operation of the oven if the door is ajar. Some hospitals place signs near their ovens cautioning people with pacemakers to keep away. The *Journal of the American Medical Association* warns of the "likelihood of hazardous encounters" to pacemaker patients when in the vicinity of microwaves. However, the FDA claims that "the problem has been largely resolved since pacemakers are now designed so they are shielded against such electrical interference."

Even after the standard went in-

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Continued From Page 51

to effect, General Electric had to recall 5,300 of 6,026 ovens made between July and November 1973, and 9,900 of 12,854 ovens made before July 1973. The recall was prompted by reports that these ovens were leaking in excess of the standard. As a result, *Consumer Reports* in 1973 issued a "Not Recommended" verdict on microwave ovens. By 1976, with improvements of door seals and locks, the uneasiness of *Consumer Reports* lessened, although they remained concerned that no one knew whether long-term exposure to microwaves at the level allowed by the government was safe.

In August 1977, *Good Housekeeping* assured readers that "we can still say that all ovens made since October 1971 meet stringent federal standards. Unless grossly abused, the microwave oven remains the safest appliance in the house."

The question to be answered is: How safe is the American standard of 10,000 microwatts for nonionizing radiation? To find out, the EPA launched studies. On March 29, 1978, the General Accounting Office reported: "Whether low-level environmental exposures (to nonionizing radiation) constitute significant health risks remains an open question. EPA is finding preliminary results that such exposure may affect the immune system, create anomalies in mouse litters, such as hernias of the brain, and produce a trend toward lowered behavioral performance. Although the signficance of these preliminary results is still being evaluated, EPA officials agree that to dismiss the Soviet observations of low-level effects would be a mistake."

A study EPA funded at Stanford Research Institute was completed in February 1978. Researchers irradiated pregnant monkeys and some of their offspring with 10,000 microwatt doses of microwaves for three hours a day, five days a week. Of nine monkeys born to irradiated mothers, five of them died within six months. Four of the five had received radiation after birth. However, in a group that received no irradiation, none of the baby monkeys died.

Since the jury is still out on the health effects from nonionizing radiation, consider only ionizing. Suppose the ionizing radiation you're getting is 25 mrems a year. That would be 25 percent in excess of background radiation. The excess may be doing you no harm. On the other hand, consider a few questions about a different sort of catastrophe: What would happen if the natural level of the Atlantic or Pacific Oceans were raised 25 percent? What if the average temperature of the earth suddenly increased 25 percent? What would the biological effects be?

No one really knows, but our gut feeling is that disaster would be imminent. What we do know is that we are all test animals in our own radiation experiment. ■

DILEMMA 2:
An Infinite Source Of Energy

President Robert Schmid is confronted with one of the most difficult decisions of his administration. Before him is a bill authorizing *one trillion dollars* in funds to be spent on the full scale development of a satellite solar power plant. This satellite will significantly help solve the country's critical energy problem. Oil producers have been unable to keep up with the increased demand for petroleum and the reserves are running low. Coal powered electricity plants have created severe air pollution problems such as smog, acid rain and increased CO_2 in the atmosphere. Home solar systems for heating have reduced demands for electricity in some areas with abundant sunshine, but the electricity needs of large cities and industries have strained the limits of the existing power plants. Citizens have voted against the construction of additional nuclear power plants, and several existing plants have been forced to close because of reactor safety problems. New sources of electricity simply must be developed, or else the country will come to a standstill.

Harnessing the boundless energy of the sun with solar collectors in space is the solution approved by Congress. Solar energy can be converted into electricity and beamed down to earth in the form of microwave energy to a receiving station. The advantages of orbiting power plants are many: valuable earth resources are not consumed, no chemical pollutants are produced, they create much less thermal pollution than existing types of power plants. Our advanced technology will be applied. Unlike earth based solar collectors, the system will produce electricity day and night. A single satellite can generate enough electricity to meet the needs of 10 million people.

President Schmid, of course, recognizes the importance of insuring the country a future source of electricity, but is personally opposed to the idea of microwave solar-power satellites. Massive amounts of funds will be poured into research and development of the system, and there is no guarantee that it will work. Other needed projects will be sacrificed.

The large size of the solar collectors — several miles long — require assembly in space and will depend upon a reliable space transportation system — the space shuttle which is still in experimental stages. Over 250 space shuttle trips will be required just to transport the parts up to space, not to mention the crews needed to assemble the components or remotely direct the assembly from space platforms. Transportation alone will require great amounts of fuel. Then there is the consideration of raw materials. Large amounts of aluminum and platinum are used and this will place a drain on those resources. The microwave beam to be collected by a 7-mile diameter receiving antenna also poses some difficulties. An area of at least 200 square miles around the antenna must be fenced off to protect the public from possible microwave radiation exposure. However, it's not possible to prevent birds and aircraft from flying through the beam. Also, an orbiting satellite is vulnerable to attack by unfriendly nations. Crippling the satellite could bring an entire state to a grinding halt.

All things considered, President Schmid feels that he should not commit the resources of the country (money, technology, rare metals) to such a massive project. The risks in a project requiring high level sophisticated technology are too many. Even if the first space power plant were built and proved functional, it would still serve only a small section of the country. He considers vetoing the bill. Should President Schmid veto the bill passed by Congress? Why or why not?

DISCUSSION QUESTIONS

- What other types of unknown effects might Solar Satellite Power Plants (SSPP) produce?
- Do you think the President is acting in the best interest of the country if he vetoes the bill?
- Since the SSPP requires such a large investment, should the people have a voice in the matter (such as a special vote)? Will they have sufficient technical knowledge to make a wise decision?
- If the scientific experts judge the project as technologically feasible with minimal undesirable side effects, should that be sufficient basis to proceed? (Did anyone ever foresee the problems with Three Mile Island?)
- Since the country has the scientific and technological expertise for the SSPP, isn't that reason enough to try the new technology?
- Should it be the President's duty to insure that the country has sufficient electrical power in the future? Why or why not?
- Should our country be expected to assist other countries to develop SSPP's even though they cannot afford the great expenses? Why or why not?
- Should our country be willing to scrap the project if it were discovered that the microwave caused undesirable change in the weather? How might other countries feel about one country creating such a drastic environmental change? Should they be expected to accept such consequences? Explain your answers.
- Although the dosage of radiation exposure from the microwave beam will be well within U.S. standards, it far exceeds that set by the Soviet Union. Should the government go ahead with a project that will expose people to radiation levels that exceed those set by another country?
- Building a SSPP may be one of our nation's greatest scientific technological achievements. Is that an important goal for the President to consider when making his decision? Explain.
- Assembling the power station may produce many types of waste materials. Do we have a right to leave it up in space?
- What do we do with the orbiting satellites, miles long, after they are no longer serviceable?

GENETIC ENGINEERING AND NEW LIFE FORMS

The technique of splicing genes, the material which controls the functioning of all living things, has opened new horizons for medicine, industry, agriculture and research. The transfer of a gene from one organism to another offers the possibility of creating new forms of life capable of producing human hormones, synfuels, cancer drugs, antifreeze, plastics, insecticides, protein foods, and new strains of plants as well as organisms that clean up oil spills. However, this technology has been a central topic of controversy among many people, ranging from scientists to manufacturers. Scientists are now in conflict over the safety question of recombinant DNA research; the citizens of Cambridge have sought to prohibit genetic research at Harvard University; and the creators of the new life forms claim that they are the owners of those living things. (The Supreme Court has recently ruled that the new life forms can be patented.)

The prospects of creating new types of living things or drastically changing existing life presents us with awesome power. We face the critical question of whether or not we will be able to use this technology wisely and safely. Will we unleash new organisms that can rampantly contaminate our environments? Will we create human monsters? Questions of this nature are addressed in the following article and dilemma discussion.

Reading 10

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The Miracles of Spliced Genes

Scientists call it "the construction of biologically functional bacterial plasmids *in vitro*." To laymen, what it means is the creation of new forms of life.

The technology, popularly known as recombinant DNA, is only about seven years old, but it has already become almost routine. In laboratories all over the world, biologists are taking genes from one organism and planting them into another. So far, the gene splicers have succeeded in inducing bacteria to make human insulin and several other hormones. And that's only the beginning. Someday, bacteria will be turned into living factories: they will churn out vast quantities of vital medical substances, including serums and vaccines, to fight diseases ranging from hepatitis to cancer and the common cold. "Anything that is basically a protein will be makable in unlimited quantities in the next fifteen years," says David Baltimore of the Massachusetts Institute of Technology.

Revolution: The impact of genetic engineering on the world's economy could almost equal the recent revolution in microelectronics (page 70). Single-celled organisms might yield the proteins that now come from cattle, which would help alleviate world food shortages. Implanted genes could increase the yield of alcohol from corn. Genetically engineered bacteria are being designed to eat their way through oil spills and to extract scarce minerals from the soil. "There has been a golden age of chemistry and a golden age of physics," says Peter Farley, president of Cetus Corp., one of the young companies organized to capitalize on recombinant DNA's potential. "Now it's biology's turn."

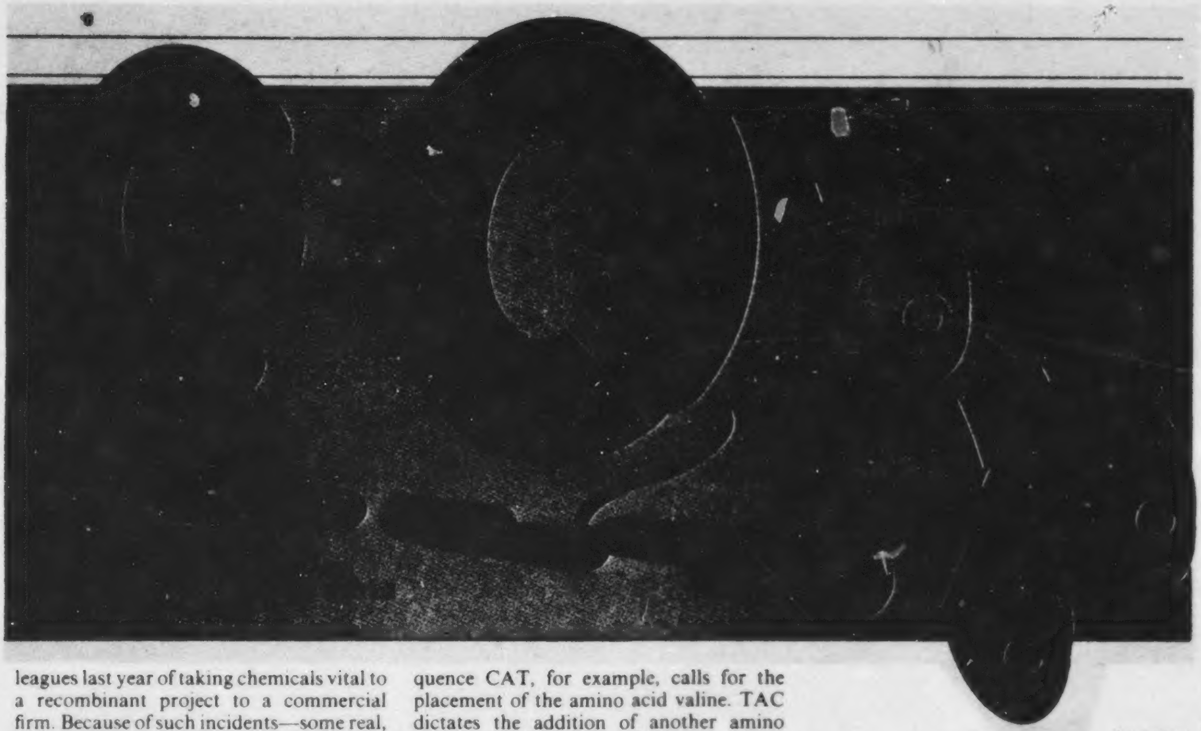
As pure science, recombinant DNA represents the most significant step in genetics since James Watson and Francis Crick discovered the double helix in 1953. It will enable scientists to identify each and every one of the 100,000 genes in the human cell. This knowledge might be used to replace defective genes with healthy ones and overcome such genetic diseases as hemophilia and sickle-cell anemia. Some technologists even suggest that the breakthrough will enable science to fashion "better" human beings. By harvesting genes at will, researchers also hope to find the answers to baffling biological questions. How do cells with the same genes differentiate into skin, muscle and nerve? What makes a normal cell turn malignant? "Recombinant DNA will not only let us understand diseases such as birth defects and cancer, but will also help us understand ourselves," says molecular biologist Phillip Sharp of MIT.

By turning bacteria into living factories, scientists can cure disease and create new forms of life.

All scientific revolutions—from Galileo's observations of the planets to the splitting of the atom—evoke the cry of heresy. Recombinant DNA is no exception. From the dawn of the recombinant era, many laymen have wondered whether scientists have gone too far by mixing genes that nature ordained to live apart. Among the first to challenge the new technology were scientists themselves. They feared that bacteria containing noxious genes could burst out of the lab and spread the earth with a man-made plague of untold horror.

While they pondered such scenarios, scientists imposed upon themselves a moratorium on most recombinant studies. Expanded research programs began in 1976 only after the National Institutes of Health issued guidelines imposing strict safeguards in the laboratory. Fortunately, no real-life Andromeda Strain has emerged, and most scientists agree that their worst anxieties were unfounded. "There was an overreaction from the beginning," says Howard Goodman of the University of California, San Francisco. "The concern exceeded the hazards, which were all theoretical." In January, the NIH relaxed its guidelines to facilitate research.

Locked Drawers: Now the scientists have other concerns. They worry that the pristine realm of pure science may become contaminated by the tantalizing economic promise of the new DNA research. They fear that exclusive patents may become as coveted as Nobel prizes. A California researcher was accused by university col-



Bob Conrad

leagues last year of taking chemicals vital to a recombinant project to a commercial firm. Because of such incidents—some real, some rumored—scientists worry that the free exchange of information traditional to science will give way to closed notebooks and locked drawers. "With millions of dollars coming into labs, suddenly scientists aren't scientists anymore," complains one prominent biologist.

Faustian bargains between the scientist and the entrepreneur have been struck before. But in this deal, the item for sale is nothing less than the fundamental chemical blueprint of life—the gene. The form and function of every living plant and animal are determined by molecules of deoxyribonucleic acid (DNA), formed into the famous double helix described by Watson and Crick. Whenever cells divide, the DNA duplicates itself, passing on its genetic inheritance to the next generation of cells. DNA also guides the cell in the manufacture of proteins essential for life, including hormones like insulin, antibodies to fight disease, hemoglobin to carry oxygen and enzymes that carry out chemical reactions.

DNA resembles a spiral ladder. The sides are formed of sugars and phosphates. The rungs are formed of pairs of the four chemical bases, adenine (A), guanine (G), cytosine (C) and thymine (T). To form a rung, A always joins with T and C with G. The sequence of bases running along a strand of DNA forms a code that tells the cell what protein to make. Proteins consist of amino acids hooked together like the cars of a train. A specific three-letter sequence of DNA bases orders up a particular amino acid that, after a series of intermediate steps, takes its place on the protein the cell is assembling. The sequence CAT, for example, calls for the placement of the amino acid valine. TAC dictates the addition of another amino acid, methionine. Three-letter codes of bases exist for each of the twenty amino acids that living cells use to make proteins.

Fragment: In recombinant technology, DNA is spliced from one type of cell to another (diagram). Researchers take bacteria, viruses, animal cells or plant cells, break them apart and extract the DNA. They use enzymes to cut the DNA chemically at specific points along its length. They can then pull out a DNA fragment with the particular array of bases they want to study. This gene is linked to the DNA of one type of *Escherichia coli*, a bacterium that normally flourishes harmlessly in the intestinal tract.

E. coli contain rings of DNA called plasmids. The researchers remove a plasmid, open the ring with a cutting enzyme and insert the new fragment of DNA. They close the ring with an annealing enzyme and put the plasmid back into the bacterium. Each time the bacterial cell divides, it will pass the new gene along to the next generation and, in a matter of hours, the researchers have thousands of bacteria containing the hybrid DNA. The new colony, a genetic clone, will produce the specific protein determined by the inserted gene. In the pioneering experiment described in 1973, Stanley Cohen and Annie Chang of Stanford and Herbert Boyer and Robert Helling of UCSF inserted a gene into E. coli that makes the salmonella germ resistant to the antibiotic streptomycin. The E. coli then became resistant themselves.

Potent Poisons: The possibility of accidentally spreading genes that make bacteria resistant to antibiotics was one of the concerns that triggered the debate over the safety of recombinant research. And under the new NIH guidelines, research on resistance genes remains largely restricted. Also under tight controls are experiments involving the DNA of disease-causing bacteria or viruses, and genes for the synthesis of potent poisons. Such research must be carried out in top-security "P4" labs, in which workers must change clothes and shower before leaving, and handle their bacteria under sealed hoods to ensure containment. No such research is going on now. Under the revised guidelines, nearly 80 per cent of recombinant research can be done with the sterile procedures that normally prevail in any hospital lab. These include decontaminating items before disposal and a ban on food at the workbench.

Scientists revised their thinking about the hazards of recombinant work after achieving a better understanding of the bugs they were working with. The K-12 strain of E. coli used in most experiments has lost its capacity to survive for long outside the laboratory and spread dangerous genes. Human genes, moreover, differ so much from the genes of their bacterial hosts that they function only under conditions controlled by the researcher. "People worried about inadvertently creating something dangerous," says Walter Gilbert of Harvard. "But scientists now know they could not even deliberately create something dangerous."

Still, some researchers believe that the safety issue is being swept under the rug. "For the first time, biologists have a chance to get rich so there is very strong peer pressure to go along," says Richard Goldstein of Harvard. Allegedly, some researchers have lost their jobs for voicing their concerns too publicly. One safety question that remains is the potential hazard to workers in plants where protein-producing E. coli are grown in vat-size quantities. "At such levels, you might have a direct toxic effect," says Baltimore.

Chains: Among the first recombinant products to be manufactured in enormous quantities will be human insulin. Insulin is a protein consisting of two chains of amino acids. In 1978, researchers at City of Hope National Medical Center, Duarte, Calif., took the first step by making chemically some fragments of the gene for insulin. Scientists at Genentech, Inc., of South San Francisco, another of the new firms set up to exploit recombinant research, assembled the fragments and inserted the synthetic genes for each of the two insulin chains into E. coli plasmids. Alongside, they implanted a regulatory mechanism called the lac operon, which serves as an "on-off" switch to activate the insulin genes. Once the plasmids were put back into E. coli, the insulin genes responded and the bacteria began turning out insulin chains. The insulin now used by diabetics comes from cattle or pigs and contains impurities that can cause allergic reactions. Once full-scale production begins, human insulin made by bacteria promises to provide a cheaper and safer alternative.

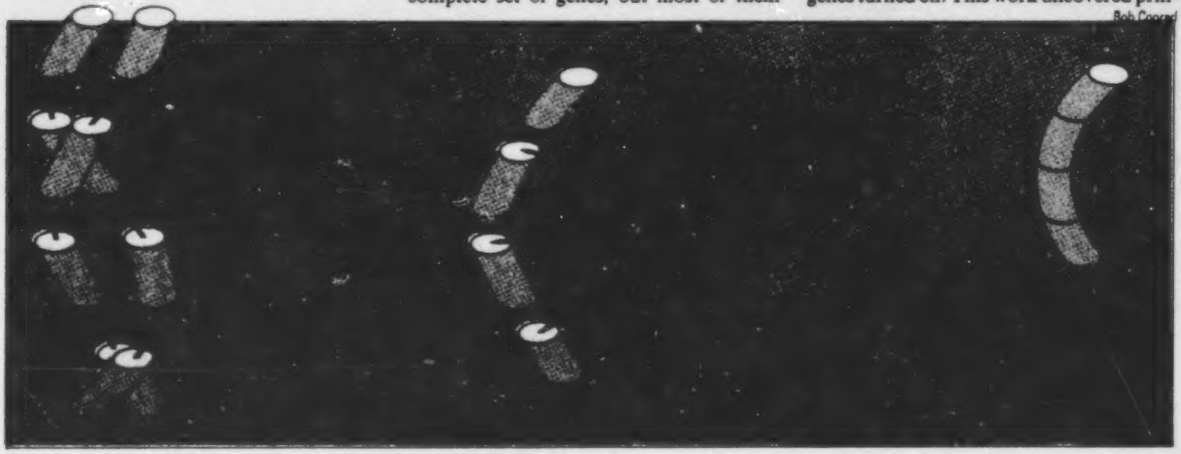
Recombinant techniques have started to produce other important human proteins. Two months ago, researchers at the University of Zurich and Biogen, S.A., of Geneva reported inducing E. coli to make interferon, a natural virus fighter. Interferon may help prevent flu, hepatitis and other viral infections and is now being tested against cancer. The quantity of interferon that could be made available through bacteria is significant; interferon research has been hampered by the fact that the substance can now only be extracted in small amounts from such sources as white blood cells. Costs of a single course of treatment run as high as $50,000. Pituitary growth hormone necessary for the treatment of certain types of dwarfism is also scarce and costly, but researchers have begun producing it through recombinant methods. Some day, they may use the same techniques to make Factor VIII, the blood protein that victims of hemophilia need to prevent bleeding.

Scientists are also using recombinant methods to unravel basic mysteries about genes. One is how genes are regulated. All cells, except eggs and sperm, contain a complete set of genes, but most of them don't do anything until they are somehow "turned on." At least one type of gene regulation has now been explained by Mark Ptashne and his colleagues at Harvard, using a standard lab virus called "lambda."

Lambda readily invades E. coli, where it adopts either of two radically different lifestyles. In one, lambda DNA takes over the machinery of the bacterium and forces it to make more lambda viruses. The E. coli bursts, releasing the new lambdas, then dies. In its other mode, the lambda DNA remains harmlessly quiescent as the bacteria reproduce generation after generation.

Message: How the lambda genes behave, the researchers showed, depends in large part on "repressor" molecules (top diagram). Normally, DNA sends messages for protein syntheses with the aid of a "transcribing" enzyme. But if a repressor molecule lies on a gene, the enzyme can't pick up DNA's instructions, and the gene remains inactive. Ptashne discovered that the same repressor molecule can also turn genes on. Depending on how the repressor is positioned within the "control region" of the DNA, it can either attract the transcribing enzyme, thus turning on the genes for viral reproduction, or deflect it, thus keeping the genes turned off. This work uncovered prin-

Bob Conrad, Cynthia Z. Rachlin—Newsweek



Bob Conrad

ciples of gene regulation that may let scientists insert genes of higher organisms into bacteria, and also switch them on.

Scientists now can also determine both the exact sequence of bases in a piece of DNA and the precise locations of genes within chromosomes. There are hundreds of thousands of possible combinations of sequences within genes; because researchers have the ability to produce genes in enormous quantities, they can finally study enough genes to map the bases.

Similarly, biologists can tell how the total of more than 100,000 human genes fit into the 46 chromosomes. To accomplish this, scientists clone a gene and mix it with chromosomes whose DNA spirals have been split down the middle. The DNA bases of the "test" gene automatically find their natural partners in the appropriate split chromosome, A to T and C to G. Thus, researchers will learn both which chromosome the gene naturally fits into and where on that chromosome the gene normally rests. This "gene mapping" might make possible the cure of inherited diseases like sickle-cell anemia and hemophilia, which result from defects in a single gene. If scientists locate the proper chromosome, they could repair the defective gene or insert a properly functioning new gene into the cell.

Clue: The new DNA research could even help cope with the riddle of cancer. J. Michael Bishop and his colleagues at UCSF have cloned genes of viruses that cause tumors in chickens and isolated those that turn cells malignant. One of the tumor-causing genes instructs the cell to make an enzyme that transfers phosphate molecules to proteins. "Our hypothesis is that this transfer of molecules causes cancerous growth," Bishop says. So far the hypothesis has not led to the development of a therapeutic strategy.

Scientists have also found that the tumor genes that invade the cell are virtually the same as genes that already inhabit it. Bishop suggests this may indicate how cells grow and differentiate: if the invading gene causes cancer by making cells proliferate uncontrollably, its harmless counterpart might normally control growth and differentiation. Thus, the study of cancer, a medical problem, may lead to a better understanding of the science of cell differentiation.

Now that gene splicing is so relatively easy, scientists find they can re-examine old genetic dogmas. Until recently, for instance, microbiologists assumed that the genes of bacteria were just like those in higher organisms. But scientists led by Sharp at MIT and Philip Leder of NIH independently discovered a startling difference. All the bases in bacterial DNA are read by enzymes three by three and translated directly into amino acids. But in viral and mammalian DNA, they found, the elements of DNA that code for amino acids that are used to make protein are separated by sequences that don't seem to get translated into any protein at all.

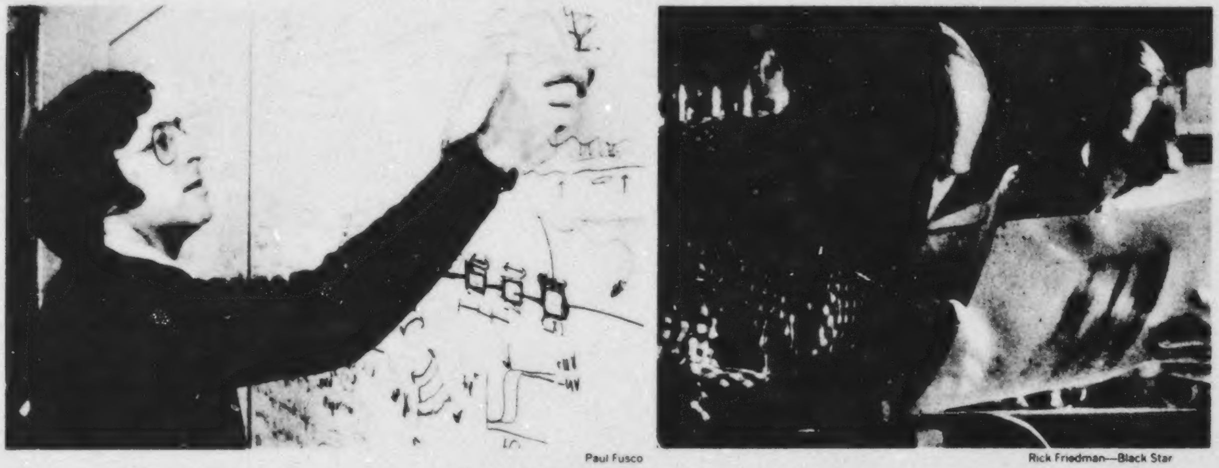
The discovery of these intervening sequences, or "introns," alters the conventional picture of how human genes work (bottom diagram, page 64). DNA bases are copied into a molecule of ribonucleic acid (RNA). But before the appropriate information is carried to the region of the cell where amino acids are assembled to make proteins, enzymes must first process the RNA. They must cut the introns out of the RNA and splice the remaining coding segments together. "This discovery is the biggest thing yet to come out of cloning DNA," wrote John Rogers of UCLA.

If genes are divided into pieces, nature must have a reason. Harvard's Gilbert thinks that piecemeal genes may have helped man evolve. Words separated by spaces can be moved around to form meaningful new sentences with less confusion than if words were strung out in an uninterrupted line. Similarly, Gilbert suggests, the messages of DNA can be shuffled more easily into new combinations that make new genes if they are separated by introns. These fresh combinations of DNA might change the character of a cell and give the organism a selective advantage.

Another surprise came from the lab of Alexander Rich at MIT. Rich and his colleagues made crystals of DNA and found that they didn't look anything like Watson and Crick's graceful spiral. The pioneers of the double helix propounded their model from studying vague X-ray scattering patterns. Rich's crystals yielded sharp pictures that showed individual atoms in DNA for the first time. The crystallized DNA formed a zigzag shape that twisted left instead of a smooth curve twisting right. It is still uncertain why or when it takes that configuration at times.

Ideal Human: Rich thinks that the "Z-DNA," as he calls it, may possibly be involved in cancer. Cancer-causing chemicals could more easily reach the exposed bases. The smooth spiral of DNA can change into the Z form at special sequences of bases, so a small number of such transformations could attract carcinogens and trigger the start of cancer. Rich also believes that genes may change from smooth to Z-DNA to turn themselves off in certain circumstances. "It's still like a new baby," he says. "We don't really know yet what it will grow up to be."

At the extreme of the new genetic research is the question of whether gene splicing could be used to create the ideal human being. Reputable scientists regard that prospect as fantasy. It is one thing to understand the basic blueprint written in the genes; it is quite another to translate the blueprint into an individual. In the formation of any organism, many gene products interact, and the circuitry is staggeringly complex. Besides, the final product of the genes—be it an Einstein or an idiot—is also shaped by environment. "Because of these complexities," says Jonathan King of MIT,


Paul Fusco

Rick Friedman—Black Star

Harvard's Ptashne, UCSF's Goodman with aide: Promises of vast quantities of serums and vaccines "attempts to modify human beings through genetic manipulation is a policy of false eugenics. It will do more damage than it will anything else."

There is much that scientists don't know about DNA, and one tangential element of their rapidly advancing research troubles many of them. They fear that the commercial potential of their findings may hamper the flow of information that helps make research succeed. Traditionally, many important scientific ideas have arisen from free and informal contacts among researchers. The Cohen-Boyer collaboration that led to the first recombinant-DNA breakthrough began over sandwiches during a lunch break at a biology symposium. "Scientists go off in the evenings and kick ideas around," says MIT's Sharp. "People who are being secretive won't participate and they'll suffer for it."

Ethics: The tantalizing lure of profits from recombinant DNA has already intruded on the sanctity of the academic lab. Scientists were shocked last year when Peter Seeburg, an assistant of John Baxter's at UCSF, left for Genentech and took with him some material to be used in producing growth hormone. Some researchers questioned the ethics of Seeburg's action, but he maintains that he had started the project and was entitled to the material and a share in any patent rights that might come from it.

The role of commercialism in DNA research may be decided soon by the U.S. Supreme Court. Last year, the Court agreed to decide whether new forms of life can be patented. If they can, a scientist and a company would be entitled to sell the resulting product exclusively for seventeen years. Should the Court rule against patents, some scientists fear that their colleagues will resort even further to secrecy. "I hope we will be able to go the patent route and publish freely," says a university biologist who is also associated with a

Bridgid Hanggi—Hoffman-La Roche

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Turning germs into assembly lines: Hoffman-La Roche researcher studies culture dish; colony of E. coli awaiting new genes

How Molecular Biology Is Spawning an Industry

How big is the market for a process that makes plants manufacture their own fertilizer? For microorganisms that mine silver, gold and copper ore? For chemicals that could be used for everything from floor wax to salad dressing? The answers are impossible to calculate with any precision, but by every estimate, the possibilities for the infant industry spawned by molecular biology are staggering. "This work is broader in importance than anything since the discovery of atomic particles," says Irving S. Johnson, vice president for research at Eli Lilly and Co. "The commercial applications for recombinant DNA are limited only to the imaginations of the people using it."

The visionaries of the business world are already hard at work. Over the past few years, a handful of small companies have sprung up for the purpose of harnessing the commercial potential of gene splicing. Big corporations are funding their work and starting in-house projects of their own. So far, not a single new product has come to market as a result of the research. And some formidable problems stand in the way of full-scale development—from questions of public safety to disputes over patents and marketing ethics. But from Wall Street to the boardrooms of the West, investor interest in DNA is steadily quickening. "We don't know whether its great impact is going to be in medicine or industrial processes or in the agricultural area," says Gordon C. McKeague, manager of corporate development for Standard Oil of Indiana. "But three years ago we saw the need and the possibilities, and felt the best thing was to get in on it then."

What businessmen find so intriguing about recombinant-DNA technology is the promise that it may someday do many jobs more efficiently—and at less cost—than the techniques they now use. "You can take the DNA from a conventional antibiotic-producing strain of microorganism, which normally grows very slowly," explains molecular biologist J. Leslie Glick, "and stick it into a fast-growing microorganism to produce a good deal of that antibiotic in a much shorter time." The same process could be used to enhance the natural ability of certain fungi and bacteria to produce small amounts of petrochemical derivates, from plastics to organic pigments, thus eliminating the need for conventional chemical synthesis. "The cost is lower because the amount of energy consumed in the process is much lower," says Glick. "Pollution is no problem because only natural products are excreted."

Stock: To explore and exploit the new market, Glick and other like-minded scientists have formed companies of their own. Glick heads Genex Corp., in Rockville, Md., which has grown from a full-time staff of three last May to 30 today and, claims Glick, is worth $75 million. Genentech, Inc., a South San Francisco company, relies heavily for funds on venture-capital firms—one of which recently paid $10 million for 15 per cent of Genentech's stock. Cetus Corp., of Berkeley, Calif., says it is worth $300 million, with 65 per cent of its stock held by Standard Oil of California, Standard Oil of Indiana and National Distillers and Chemical Corp. The latest comer is Switzerland's Biogen, S.A., private firm. But others find no benefit in this manner of exclusivity. "There is enough potential in the field that it doesn't need patent protection to stimulate activity," says MIT's Baltimore.

Research Standards: DNA research has attracted so much attention from the public, and from investors, that it has generated still another anxiety—what researchers call "science by press conference." Instead of presenting their work in traditional fashion to a scientific journal, where it can be "refereed" or evaluated by authorities before it is published, some scientists now rush their findings directly to the media. The City of Hope-Genentech team, for example, announced the production of insulin at a press conference before it had done the additional—and necessary—work to show that the hormone actually functioned. (Only about nine months later did Eli Lilly and Co. show that the bacteria-created insulin really worked.) Such premature announcement of results could reduce scientists' credibility and lower the standards of research. But many scientists remain confident that pure science and industry can work together. "Biologists have been unworldly," says Rich. "Chemists have been living in the commercial world for 50 years and still do exciting research."

To good scientists, research is exciting for its own sake. That's why they split atomic nuclei, listen to electronic impulses from the galaxies and fiddle with strands of DNA in the first place. Whether their discoveries simply add arcane footnotes to the scientific literature or launch whole new fields of industrial endeavor remains of secondary concern. The burgeoning gene research promises to do a great deal of both. It will lift the curtain further on the ultimate secrets of life on Earth. And it will also enrich the lives of the planet's restless inhabitants.

MATT CLARK with SHARON BEGLEY
in Cambridge, Mass., and San Francisco
and MARY HAGER in Washington

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which boasts heavy investments by Schering-Plough Corp., a big U.S. pharmaceutical firm, and International Nickel Co., Inc.

According to Nelson M. Schneider, drug-industry analyst for E.F. Hutton, it was Biogen's January announcement that it had successfully produced human interferon through gene splicing "that showed recombinant-DNA research had reached beyond the Model T stage," and spurred investor interest in the field. All the projects at the new gene companies are at least one to five years from commercial exploitation. But many seem to have breath-taking potential. Genex, for example, is experimenting with DNA technology to correct sickle-cell anemia, a genetic defect that affects about 50,000 black Americans. Cetus is working on one strain of microbes that could substantially boost the efficiency of distillers' alcohol production. Genentech has arranged a joint venture with the U.S. Department of Agriculture to produce a vaccine that combats foot-and-mouth disease, a global plague that forces the slaughter of 100 million animals a year.

Meanwhile, at least a dozen major drug and chemical companies have launched their own DNA projects. Merck and Co. of Rahway, N.J., for instance, is equipping a $23 million addition to its laboratory complex for work on recombinant DNA—especially its application to antibiotics. Upjohn Co. of Kalamazoo, Mich., and Eli Lilly and Co. of Indianapolis both have scientists at work on manufacturing human insulin. Most experts believe, however, that the biggest markets will develop not in medicine, but in the nation's $150 billion-a-year chemical industry and its $130 billion-a-year agricultural sector. Glick of Genex estimates that recombinant-DNA techniques could be applied to 25 per cent of all chemical production. Du Pont scientists have turned to plant breeding. Today, says Ralph F. W. Hardy, director of life sciences in the company's central research department, technicians trying to improve plant species by increasing their food yield or their capacity for survival must rely on time-consuming methods of crossbreeding used by Gregor Mendel in the mid-nineteenth century. But by splicing one plant's desirable genes into another species, researchers might short-cut the process, with incalculable benefits to the world's food supply.

Safe look: Genex scientist in protective gear

Susan T McElhinney—Newsweek

Before the marvels of gene splicing hit the market full force, serious issues will have to be resolved. Patent law, for one, has yet to deal with the emerging technology. The U.S. Supreme Court will hear arguments next week in a case brought by General Electric Co., which wants to patent a microorganism it developed through genetic engineering: GE was turned down by a Patent and Trademark Office that opposes licensing life forms. Then there is the problem of public concern about safety. Several firms, such as Hoffman-La Roche, Inc., of Nutley, N.J., which is working on interferon, have supported community study committees to soothe fears about the research.

Ballyhoo: Finally, there is growing concern within the recombinant-DNA industry over marketing ethics. Even though most of the payoffs are a long way off, each announcement of a breakthrough is accompanied by great public ballyhoo that is often not backed up by scientific papers. The aim, dissidents charge, is to hype company stock and stampede investors into putting more money into research projects that may be considerably further from the market than the hoopla suggests. "They are telling you where they will be ten months from now," says one industry insider angrily, "as if they were there today."

Some skeptics doubt that recombinant DNA will ever fulfill the commercial promise held out by its most avid promoters. At General Electric, for instance, scientists insist that conventional genetic engineering can do many of the same jobs without the long lead times and costly investments. A single pilot plant for demonstrating the feasibility of the new technology can cost $50 million and take three years to build. Many big companies—among them, Bristol-Myers Co., American Home Products Corp. and Warner Lambert Co.—are holding off, hoping to cash in later if their competitors prove successful.

The delay could turn out to be costly. Already, the new technology is outpacing all forecasts. Just last September, for example, experts at an investor-sponsored recombinant-DNA conference predicted that the bacterial production of human interferon was at least three years away; Biogen's announcement followed just four months later. "Eventually, those who have held out will have to scramble to get into the game," says analyst Schneider. "They're going to have to buy into it, and the price will be high." Still, the market for DNA's wonders will almost certainly be so huge that even a late investment may well be worthwhile.

MERRILL SHEILS with SUSAN DENTZER
in New York, PAMELA ABRAMSON
in San Francisco and bureau reports

DILEMMA 3:
So Human An Animal . . .

Dr. Russ Atkin is a geneticist at a bio-research lab. Working on a government sponsored project, he has the task of developing a physically stronger breed of chimpanzee for work in space colonies. Chimpanzees have proved to be important helpers in the building of space islands because they adjust easily to the low gravity environment, eat synthetic fruits and vegetables without complaint and will perform dull, repetitive tasks requiring their great arm strength for long periods. Chimps are important in the mining of metals on the surface of the moon because they, unlike robots, are far more agile and can leap around the moon's rocky surface quickly and with great ease.

So far, Russ, using the technique of gene splicing, has created chimps with longer, more powerful arms, a more streamlined body (to fit easily into small spaces such as rocket cabins), a longer life span and the ability to resist lung disease. His next task is to develop chimps with long tails so that they can maintain their balance better in a low-gravity environment.

However, Russ has a far more ambitious project which he works on after his regular job. His goal is the creation of a totally new species of animal. This animal will have the qualities of a space chimp but in addition has the ability to use language, learn quickly, think creatively and logically, and make critical decisions. To accomplish this requires a clone of highly developed brain cells. Secretly, Russ has obtained from the cryogenic repository a clone of cells from the tissue of a former astronaut. After identifying and extracting the genes controlling brain growth and intellectual development, he has successfully inserted them into six chimp embryos. Now he is awaiting their birth.

With the project nearing fruition, Russ plans to leave the research lab, patent his new animal, and form a company to sell the animals which will reach adulthood in three years. With the rapid growth of space colonies, the demands for these highly intelligent creatures are enormous. In addition to space colonies, there are countless other areas which could use them, replacing the need for human workers.

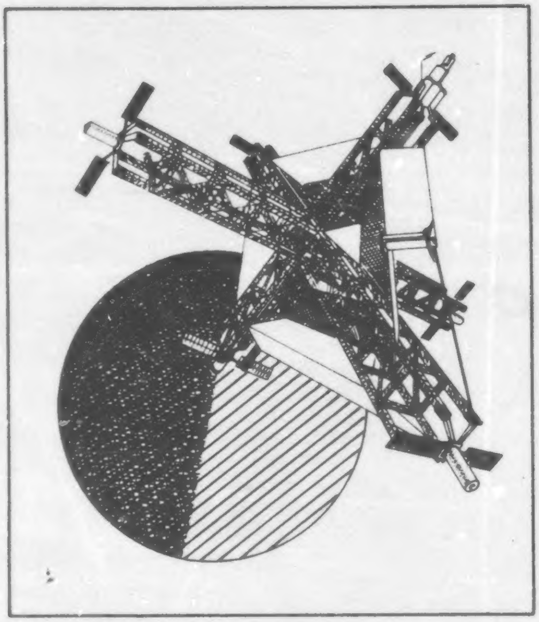
He finally decides to share his well-kept secret with his best friend, Jim, and invites him to be a partner in the company. However, to Russ Atkin's surprise, his friend, Jim, is horrified at the thought of creating such a creature. Jim accuses Russ of "playing God" and argues that he has no right to treat the human brain in such an outrageous manner. From Jim's viewpoint, Russ is breeding a new human slave — in the form of a chimp. Jim begs Russ to give up his bizarre project because he fears that people will not treat that being which can think and have feelings in a humane and respectful manner.

Should Dr. Russ Atkin end his project? Why or why not?

DISCUSSION QUESTIONS

- Should people ever tamper with human genes? Why or why not?
- If chimps possess a human brain, what rights should be granted? Why?
- Should Dr. Russ Atkin have the right to own this creation? Does he have the right to sell it?
- If Dr. Russ Atkin was granted a patent on this creation, does it mean that scientists have the legal right to transform the human brain in whatever way they desire? How might this change the concept of what is human?
- What might society be like if many other creatures have human intelligence? Should they all be treated as humans? How will their rights be protected? Will some human-like creatures be considered superior to others?
- Should humans be the only intelligent creatures on earth?
- What might be the benefits of creating more intelligent creatures? Dangers?
- If Dr. Atkin put an end to his project by destroying the embryos, will he be committing murder?
- If the creature possesses extreme antisocial qualities, should the inventor destroy it?
- Should scientists ever try to change humans so that a better race of humans will evolve? On what basis can one measure "better"?
- Is manipulating human genes any different from manipulating genes of other life forms?
- On what basis can society decide what scientist should or should not do? Do scientists have the right to perform whatever experiment they choose?
- Is it important for scientists to develop techniques to "correct" or eliminate defective human genes? How might this affect human society as we know it today?
- Do humans have the right to use genetic engineering to change the character of other living species? Plants? Animals? If this technique enables us to produce more food or other benefits, can it be justified?
- Would it be acceptable to genetically change humans, if living in space colonies required different physical characteristics such as a redesigned body?

REMOTE SENSING:
THE SCIENCE OF SURVEILLANCE



Humans, like other creatures on the earth, are curious animals. However, Homo sapiens *are the only creatures on earth with the ability to abstract and perceive phenomena which are beyond the capability of the normal senses. Thus we curious earthly creatures have developed a technology capable of identifying phenomena we cannot experience with our senses — phenomena remote to our senses. This technology is* remote sensing.

Remote sensing is the ability to detect objects or activity without the sensor in direct contact with the object to be sensed. The information is then transported in space in the form of electromagnetic radiation. Sensing devices designed to react to radiation at certain wavelengths pick up the radiation and transform it into images that we can now experience with our eyes or ears.

In the past we have used a variety of remote sensing devices. We have used cameras and infrared detectors to identify electromagnetic radiation. We have also used the seismometer to detect sound energy. Radioactivity is detected at a distance by scintillation counters, and the strength of gravity fields is measured by gravity meters. Each of us is also familiar with the remote sensing systems such as radar and sonar.

Originally, many of these devices were developed to serve the military. However, more recently, there are remote sensing systems which are being developed for, and used by, those concerned with our natural environment — geologists, oceanographers, meteorologists, etc. These systems or devices could be of great benefit to society, offering assistance in detecting forest fires for fire fighters, locating diseased crops and identifying soil types for agriculturists, identifying ice hazards and mapping ocean currents in shipping lanes, as well as identifying volcanic activity. Many additional uses are being developed every day.

Remote sensing is, indeed, a very new technology with many potential benefits to human society. However, as with almost any technology, it also presents a number of new concerns. The concerns surrounding remote sensing are explored in this section.

Reading 11

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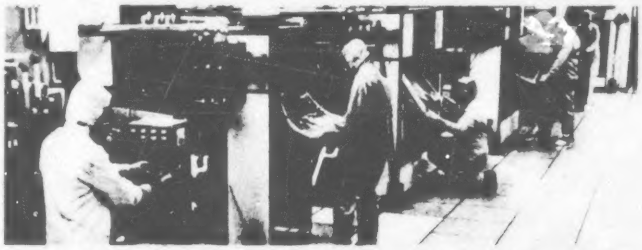
Mapping the Earth from Satellites

EROS Data Center, located on a 318-acre site 16 miles northeast of Sioux Falls, South Dakota, is operated by the U.S. Department of the Interior through the Geological Survey. Photo: U.S. Geological Survey

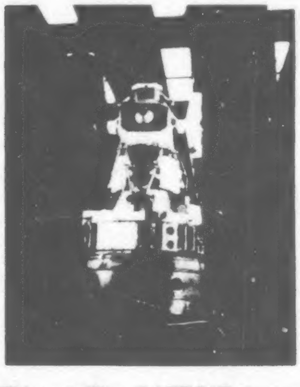


Precision photographic reproduction laboratory at EROS Data Center processes photographic products ranging from 16 millimeters to 40 inches square in a variety of formats. Personnel are clad in protective clothing to maintain the clean, dust-free laboratory environment. Photo: U.S. Geological Survey

Two satellites now are selectively monitoring the world's agricultural and forestry crops from orbits 570 miles above the earth.

Data gathered by the satellites will help provide a more complete and up-to-date picture of the world food situation than is possible by other means, thus providing an "early warning system" that will give the world's governments time to minimize the ill effects of food shortages. By monitoring water distribution and vegetation patterns, these satellites can also measure the effects of droughts. Satellite imagery is now being used for evaluating range conditions over vast areas of the western United States.

The two satellites, called LANDSAT-1 and LANDSAT-2, circle the earth approximately 14 times per day and can map the entire earth (with the exception of the extreme polar regions) every 18 days. Because they can simultaneously photograph an area 115 miles on a side, the satellites are particularly useful for mapping large regions. Repetitive mapping is helpful in studying the effects of floods and monitoring seasonal changes in vegetation, snow, and ice. The boundaries of urban growth can also be systematically recorded.



This satellite (LANDSAT-1) was launched in 1972 and is still functioning. Circling the earth 14 times every 24 hours, it continuously monitors earth resources by remote sensing devices and also relays data collected by widely scattered ground-based instruments. Photo: NASA

Geologists are using LANDSAT imagery to learn more about the structure of the earth. Satellite imagery, for example, can help pinpoint geologic structures which, in turn, assists geologists in their search for undiscovered natural resources such as oil, gas, and minerals. Hydrologists use satellite imagery to assist them in the discovery and development of water resources.

Repetitive satellite imagery has also proved effective in monitoring strip mining and reclamation of strip mines and will play an important role in assessing the environmental impact of the Alaska pipeline.

LANDSAT has also made it possible to map areas that have never before been mapped, such as parts of Antarctica and shallow seas such as the Indian Ocean, where previously uncharted reefs and other areas of shoal water have been revealed.

In addition to its global repetitive mapping capability, LANDSAT has several other advantages over airplanes: For one thing, satellites are not subject to the atmospheric turbulence which affects the quality of aerial photographs. In addition, the narrow-angle mapping done from satellites produces a geometrically correct two-dimensional rendition of the earth (the orthographic view). Aerial photography, taken from a much lower altitude, provides three-dimensional information which must be processed into a two-dimensional map, which is a costly and complex process. On the other hand, LANDSAT cannot do topographic mapping, which would show, for example, contours of mountainous regions.

Satellites can also operate for periods of years, whereas an aerial mapping flight usually lasts only a matter of hours. LANDSAT-1, originally called the Earth Resources Technology Satellite (ERTS), was launched on July 23, 1972, and is still functioning today.

A third satellite, LANDSAT-C, is scheduled to join the other two in orbit in September, 1977. LANDSAT-C will have two capabilities not possessed by its predecessors: a thermal channel which will measure temperature variations on the earth's surface and the ability to uniquely record an area as small as 40 meters on a side, compared to an 80-meter minimum for the others. Even the 40-meter image element, however, is inadequate for recording cultural details, such as most roads and buildings, which are shown on the larger scale maps.

The EROS (Earth Resources Observation Systems) Data Center was established in 1971 by the Department of the Interior to reproduce and distribute as sale items copies of imagery, photography, electronic data, and computer products collected by 16 different organizations, including the U.S. Geological Survey and NASA. In addition to the LANDSAT data, the EROS Data Center serves as the primary repository for aerial photography acquired by the U.S. Department of the Interior and for photography and imagery acquired by the National Aeronautics and Space Administration (NASA) from high altitude research aircraft and from Skylab, Apollo, and Gemini spacecraft.

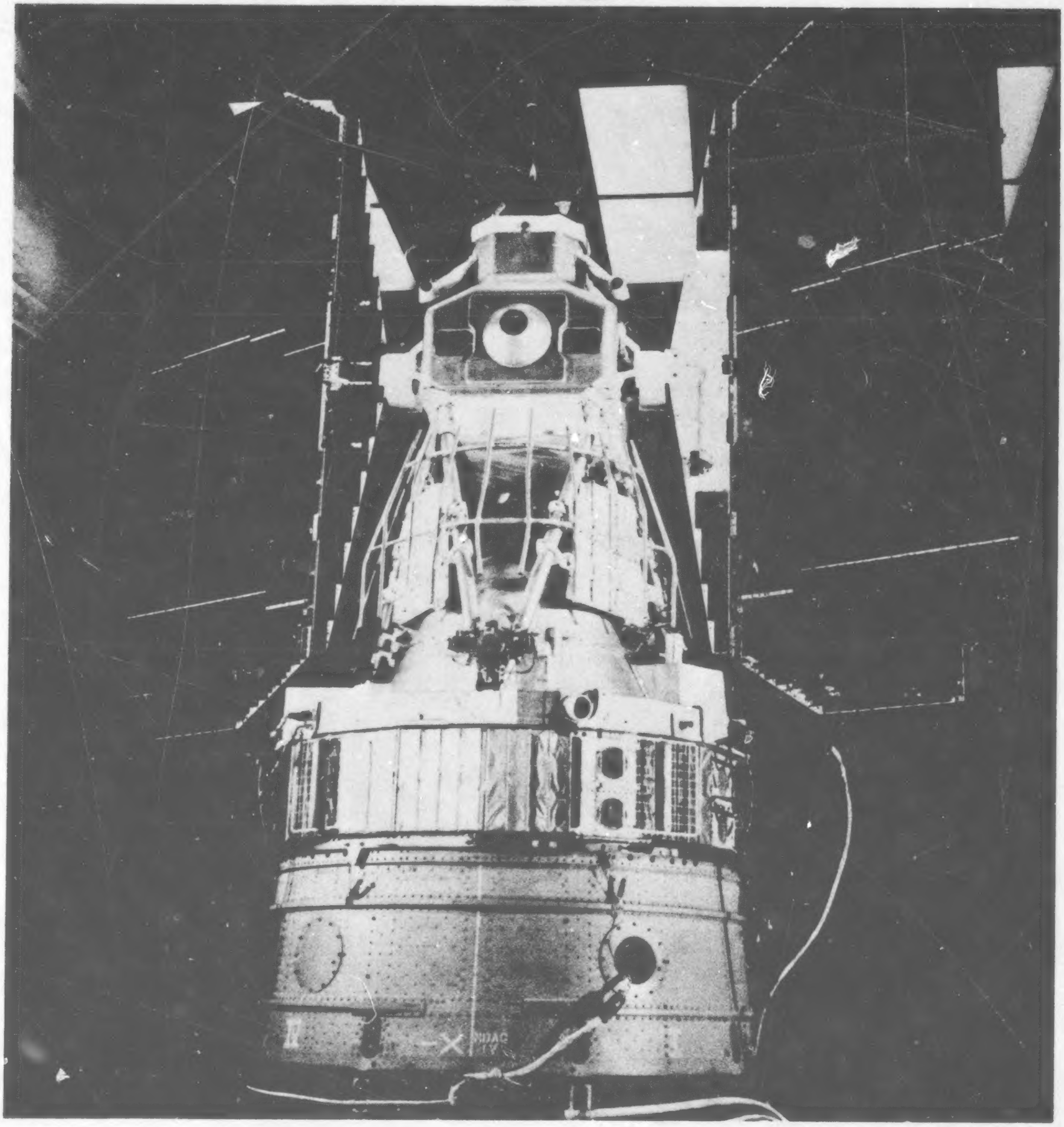
Descriptions of products available from the EROS Data Center, order forms, and price lists can be obtained from the EROS Data Center, Sioux Falls, South Dakota 57198 (Telephone: 605-594-6511). Information about satellite imagery can also be obtained from the National Cartographic Information Center, U.S. Geological Survey National Center, STOP 507, Reston, Virginia 22092 (Telephone: 603-860-6045).

(Portions of the preceding information were excerpted from the U.S. Geological Survey Annual Report, Fiscal Year 1975 and from other USGS publications. The Annual Report is available for $3.40 from Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, Virginia 22202.) ☐

Reading 12

LOOKING IN ON US

BY DON JORDAN



Surveillance, surveillance... all is surveillance

DON JORDAN is a free-lance journalist.

WHEN CAMERAS WERE mounted on balloons and pigeons during the late 1800s and early 1900s, they provided the first examples of remote sensing of the earth's surface. The importance of this technology was lost on the general public, but military interest bloomed during the increasingly technology-oriented wars which followed.

Today, however, a complex civilian "spy" industry is growing, with roots in both the U.S. government structure and the scientific community. Government bureaucrats and their corporate counterparts around the world, operating at a variety of levels, have found a tool for more efficient resource exploitation and social control.

Because of widespread use of aerial photography and satellite imagery in the decision-making processes of local, state, and federal government, as well as in private enterprise, remote sensing is no longer experimental but is an operational spin-off from decades of military development and space age computerization that must soon be reconciled with issues of individual and collective privacy.

From the free enterprise viewpoint, remote-sensing technology's most beneficial use is more efficient and effective exploitation of the world's natural resources. All the major international oil companies have used aerial or satellite data in their search for new oil deposits. One company, Texas Instruments of Dallas, has developed a service specializing in locating high-potential drilling locations.

Experiments sponsored by the National Aeronautics and Space Administration (NASA) successfully located high-potential ore-bearing areas in Nevada, where no deposits previously had been found, by using high-altitude LANDSAT (formerly Earth Resources Technology Satellite, or ERTS) imagery. Similar experiments also sponsored by NASA have surveyed forest lands, inventorying timber by type.

The National Marine Fisheries Service, a Department of Commerce agency, has successfully located prime fishing locations in the Gulf of Mexico using LANDSAT images recorded from a height of 910 kilometers (546 miles). The fisheries scientists directed fishing boats to schools of thread herring and menhaden by comparing satellite scanner data with similar information obtained from known fishing spots.

New satellites are planned which will make possible even more efficient resource exploitation. A new ocean-oriented satellite called SEASAT may be able to detect and count giant bluefin tuna in addition to the primary function of providing all-weather observation of the oceans. SEASAT will orbit at 800 kilometers (480 miles).

From Forests to Wheat

Other civilian uses of high-altitude photography range from exploration of resources to exploitation of information. For example, since images obtained by satellite and airplane are the most efficient means of exploring remote terrain, remote-sensing technology promises to be a major tool in examining the few remaining untouched parts of the world. Brazil, for example, has built its own facility to receive LANDSAT satellite transmissions, and the Canadians also have a receiving capability. Brazilians are using the data in exploring the vast rain forests, while Canadians are exploring their isolated northlands. The technology also can be used in efforts to conserve resources; the Sudanese are using LANDSAT to chart desert encroachment in hopes of finding a solution to that problem.

In addition to basic exploration, satellites have been used for several years to monitor the world's wheat crop — an activity which has advanced beyond the experimental stage. Commodities speculators are beginning to use data and methods developed in a joint U.S.-Soviet-Canadian wheat survey project. In addition, satellite imagery has been used successfully to differentiate between corn and bean fields, thus adding another factor to commodities speculation — in fact, the technology may eventually render the term "speculation" meaningless.

Government Use

Government bureaucrats at many levels rely on this technology to observe, survey, and map the earth and to observe the activities both of fellow citizens and foreign nations. Use of aerial photography by federal agencies began during the 1930s, when the nation's timber reserves and ranchlands were inventoried from low-flying airplanes. The Tennessee Valley Authority and the U.S. Army Corps of Engineers have relied upon similar photos since the 1930s in planning land acquisition campaigns and large water projects.

Even before satellite imagery was available on a widespread basis to federal bureaucrats, a large number of agencies relied upon remote-sensing technology. In 1973, a task force headed by the Office of Management and Budget's Emory E. Donelson found five defense agencies, eight interior agencies, two agriculture agencies, two transportation agencies, three commerce agencies, five independent agencies, and two international commissions involved in land surveying and mapping with remote sensing.

States are using the technology, too. In 1976, a NASA-sponsored study by Washington University scientists found that state use of aerial photography was highly popular. Also reported was a keen interest in using satellite data accompanied by a lack of funds to purchase the expensive equipment needed to interpret satellite data tapes. The study also detailed a large number of applications which states could find valuable.

Sharp-eyed Cameras

NASA has been recording the entire California coastline at the request of state planners, using high-flying U-2 aircraft. The space agency operates two of the high- altitude spy planes on loan from the U.S. Air Force. The former "black ladies of espionage" are now painted white and record the U.S. landscape in fine detail instead of the Soviet Union. In the coastline survey for California's coastal commission, ground detail was so clear that a *Newsweek* correspondent was able to identify the picnic table on his patio at home in Larkspur, California. Much better resolutions can be achieved, with weather being the prime variable above 65,000 feet.

Since only two U-2s are available for these civilian spy missions, it is not surprising to find most states relying upon commercial firms to obtain needed information. State governments generally use such photos in the same way as do federal agencies – for road and highway planning and floodplain mapping, among other applications.

Local governments also have found remote-sensing technology of value. Many county governments now routinely hire firms to map the land using aircraft. The photos are used for tax assessment purposes or for preparing maps of land ownership.

Cities rely heavily upon aerial photos for a variety of planning and mapping functions. Chicago planners have used aerial photos for planning since the 1930s, and recent NASA-funded demonstrations have shown that satellite imagery can be used for some city planning functions.

Police in the Sky

Information gathered by aircraft and satellite also has proven valuable in certain forms of law enforcement where land or ecological changes are involved. LANDSAT was used by Vermont officials to identify effluent from International Paper Corporation's mill north of Fort Ticonderoga, New York, as it entered Lake Champlain and crossed to the Vermont shore. Aerospace Systems Division of Bendix Corporation at Ann Arbor, Michigan, has applied LANDSAT imagery as an aid in surveillance and control of Great Lakes contamination. Thermal scanners aboard new LANDSATs will be able to detect hot water discharges from power plants and determine temperature differences as small as 0.2 degree C. Other sensors can track air pollution.

The U.S. Geological Survey (USGS) recently announced the release of a photomosaic map of Oregon's Wilamette River Basin based on U-2 photos exposed at 65,000 feet. The USGS points out that extensive clear-cutting is visible, as well as urbanization in the floodplain. Similar photos have revealed illegal cutting practices in other western states.

A combination of airborne and satellite data will be used to map all U.S. Standard Metropolitan Statistical Areas for the 1980 census. Photos and images of the cities will be used in a variety of planning functions, including allocation of police patrols, identification of housing conditions, and civil defense planning.

Aerial observation has been a favorite tool of police agencies for a number of years. In recent years, the federal Drug Enforcement Agency has used remote sensing to locate fields of marijuana; in Mexico, opium poppy fields are searched for from aircraft. Some state police agencies have used low-light television cameras on helicopter platforms in their efforts to locate patches of marijuana.

Gains in infrared sensing are popular with police agencies. It is now possible, for example, to observe individuals through solid walls with sophisticated infrared devices (the Dutch used these devices in planning the surprise attack on South Moluccan terrorists). These devices, similar to those used aboard LANDSAT, are also being tested by physicians attempting to locate cancers without exposing patients to X rays.

Under Surveillance

"There is a growing concern for access, control, and privacy of large integrated information systems, among government agencies, business, and the public at large," according to the 1976 Washington University study on remote-sensing applications. In addition to that observation, the study predicted a range of socioeconomic problems. One problem might be establishment of new industries specifically based on invasion of privacy. Another might be further citizen isolation from the government.

Discussing social impacts of widespread governmental use of satellite data, authors of the study warned that loss of diversity or increased standardization and increased social control and regulation were "possible" and noted that "high-resolution systems might cause citizens to feel that they and their property are under constant observation."

As the civilian U-2 projects have demonstrated, high-resolution aerial photography systems are a reality. High-resolution satellite scanner imagery is coming, but current achievements using less detailed data already have proven that even one-acre image resolutions can reveal massive amounts of information.

In fact, citizens are already under nearly constant observation – by satellite or by high-altitude or low-altitude aircraft. Bad weather is the limiting factor in making such observation continual, and SEASAT is likely to go far in eliminating that problem.

But the citizenry apparently does not yet "feel" this constant observation. This is probably because few people observe aerial photo planes or satellites passing overhead, and the connection between such overflights and governmental or corporate decisions is not easily seen. However, continued and more refined uses of remote sensing by such customers as commodities speculators may lead farmers to object for economic reasons.

The first credit bureau to offer satellite or aircraft imagery of each reference's lands, buildings, and other personal property may reap vast financial rewards. In fact, corporate privacy already has been invaded. One company successfully sued a competitor for industrial espionage; the loser in this case had hired a private firm to take aerial photos of its competitor's new manufacturing plant during construction and obtained information about secret manufacturing processes.

International Use

If low-resolution systems aboard civilian satellites offer some measure of real or imagined protection because the resulting photographs are limited in detail, no such privacy has existed in the international arena since the 1960s. Extremely sensitive American and Soviet spy satellites have been orbiting the world since those years with regular frequency, but the purpose of these satellites is primarily military. Questions about the economic advantages such satellites afford rich countries and corporations at the expense of developing nations did not arise until the civilian satellites like LANDSAT began orbiting in this decade.

Today, a complex civilian "spy" industry is growing, with roots in both the U.S. government structure and the scientific community.

The Swedes have been particularly critical of American and Soviet observation satellites – not because of military applications of data obtained but because of threats to the economic security of small countries. These objections have diminished, however, since the early 1970s. One reason for the silence may be the current NASA policy of providing the fruits of remote-sensing technology to anyone interested. At various NASA "centers of excellence" in remote-sensing applications, representatives from government agencies, industries, and foreign countries flock to learn about the latest achievements and how to utilize them.

The Laboratory for Applications of Remote Sensing (LARS) at Purdue University is one such center. LARS has offered a variety of learning opportunities since 1975. In that year, representatives from ten universities, eight private industries, fourteen federal agencies, and sixteen foreign nations attended remote-sensing courses at LARS which dealt with applications of LANDSAT data. Among the foreign nations represented were Egypt, Iran, Japan, China, Yugoslavia, and Czechoslovakia.

The U.S.-Soviet Salt I agreement settled upon satellite observation as a means of enforcing arms control, and both nations use satellites routinely to observe world trouble spots like the Middle East and Cyprus. In the U.S.S.R., military efforts to thwart remote-sensing devices are at a highly advanced stage. Lieutenant Viktor Belenko, the Soviet pilot who flew his MIG 25 to Japan last September and defected from the Soviet Air Force, related an incredible tale of Soviet activity. He told of "cold belts" buried in the earth atop hidden underground air bases in Siberia. These "cold belts" are designed to screen the air bases from infrared scanners and cameras able to detect heat radiating from troops and equipment. Belenko also told of being assigned to position dummy airplanes at decoy aboveground air bases in order to fool spy satellites and photo interpreters. The pentagon has reportedly identified 134 such decoy bases in Siberia alone.

Few Legal Safeguards

A growing number of users of remote-sensing technology are finding aircraft and satellite data useful in enforcing pollution laws, zoning laws, and even criminal codes; but there is no body of law which specifically defines the courtroom status of remote sensing.

Jeff Haynes of *Environmental Law Reporter* predicts that electronic eavesdropping laws will apply. In a partial technology assessment compiled at the Environmental Research Institute of Michigan under the leadership of George Zissis, Haynes predicts that remote-sensing imagery will be subjected to legal handling similar to that which applies to other technologies (such as bugging devices) used in law enforcement and private snooping.

"Some areas in which remote sensing will have an impact on legal rights and duties are the constitutional areas of privacy and criminal surveillance, disclosure of information gained by remote sensing in the field of investment securities, and possible utilization of remote-sensing techniques to ferret trade secrets from business establishments," wrote Haynes in a 1973 report which is still awaiting publication by the National Science Foundation.

More recently, Haynes explained that air space above an individual's property most likely belongs (in a legal sense) to the landowner, in much the same fashion as nations owning the air space over their territories. "The question may be what use is made of the pictures, but the greater worry is the

EROS Data Center

A LANDSAT image of Cape Cod filmed 570 miles above the earth's surface.

dissemination of the data." The data from the NASA LANDSAT System, for example, can be obtained by any purchaser from the Earth Resources Observation Systems (EROS) Data Center in Sioux Falls, South Dakota. "There are very few controls over what the EROS Data Center will put out – which is virtually everything they have," according to Haynes.

Satellite Politics

The major obstacle to even more widespread and continuous data dissemination is the so-called "experimental" status of LANDSAT technology, which has inhibited use of imagery by state governments, as noted by the Washington University team. A bill now pending in the U.S. Senate would eliminate this problem. Senate Bill 657, introduced by Senator Wendell Ford of Kentucky, would officially lift the "experimental" tag from LANDSAT and make it an operational technology by establishing an "Earth Resources and Environmental Information System." Regional data distribution centers would provide all LANDSAT (and presumably both aerial and astronaut photography) imagery to any customer. NASA would continue as the agency responsible for satellites and remote-sensing research and development. The Department of the Interior would continue its data management responsibilities.

The Ford measure calls for an operational system within seven years. Once established, the system would be turned over to private enterprise at "the earliest practicable date" for management. This bill is based on responses Ford obtained from 60 "companies, universities, and government agencies" which were asked for recommendations. This powerful if loosely connected political lobby (called the "LANDSAT Community") includes such industrial giants as General Electric, RCA, and IBM which, in order, produce relevant satellites, sensing equipment, and computers. The *Wall Street Journal* reported in 1975 that the LANDSAT Community was primarily responsible for obtaining presidential approval for launching the latest LANDSAT satellite – despite urging from the Office of Management and Budget that this satellite be delayed. Among those who actively lobbied for continued LANDSAT funding were General Electric, the National Academy of Sciences, and the National Academy of Engineering. NASA successfully placed a supportive article on the satellite in *Fortune* and defended the action by observing that the article was of "quite legitimate interest to businessmen." President Gerald Ford eventually allocated $11 million in his last budget for a third LANDSAT satellite.

Civilian Spy-in-the-Sky

Remote-sensing capabilities are technologically impressive. Although civilian capabilities lag behind military ones, the gap is closing rapidly.

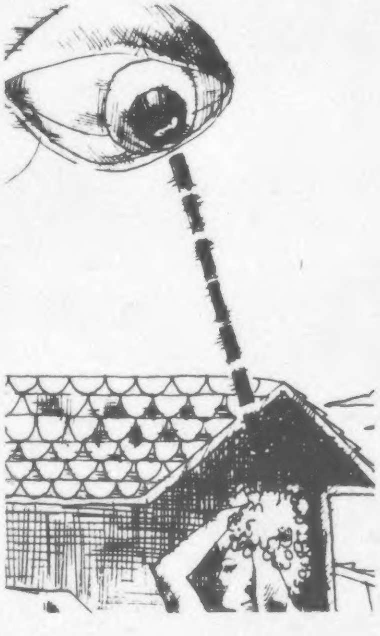
Military satellites rely heavily upon high-resolution infrared photography. Cameras are carried aboard maneuverable satellites in elliptical orbit, passing as close as 130 kilometers (78 miles) to the earth. Exposed film is ejected in a capsule which is recovered after parachuting to earth.

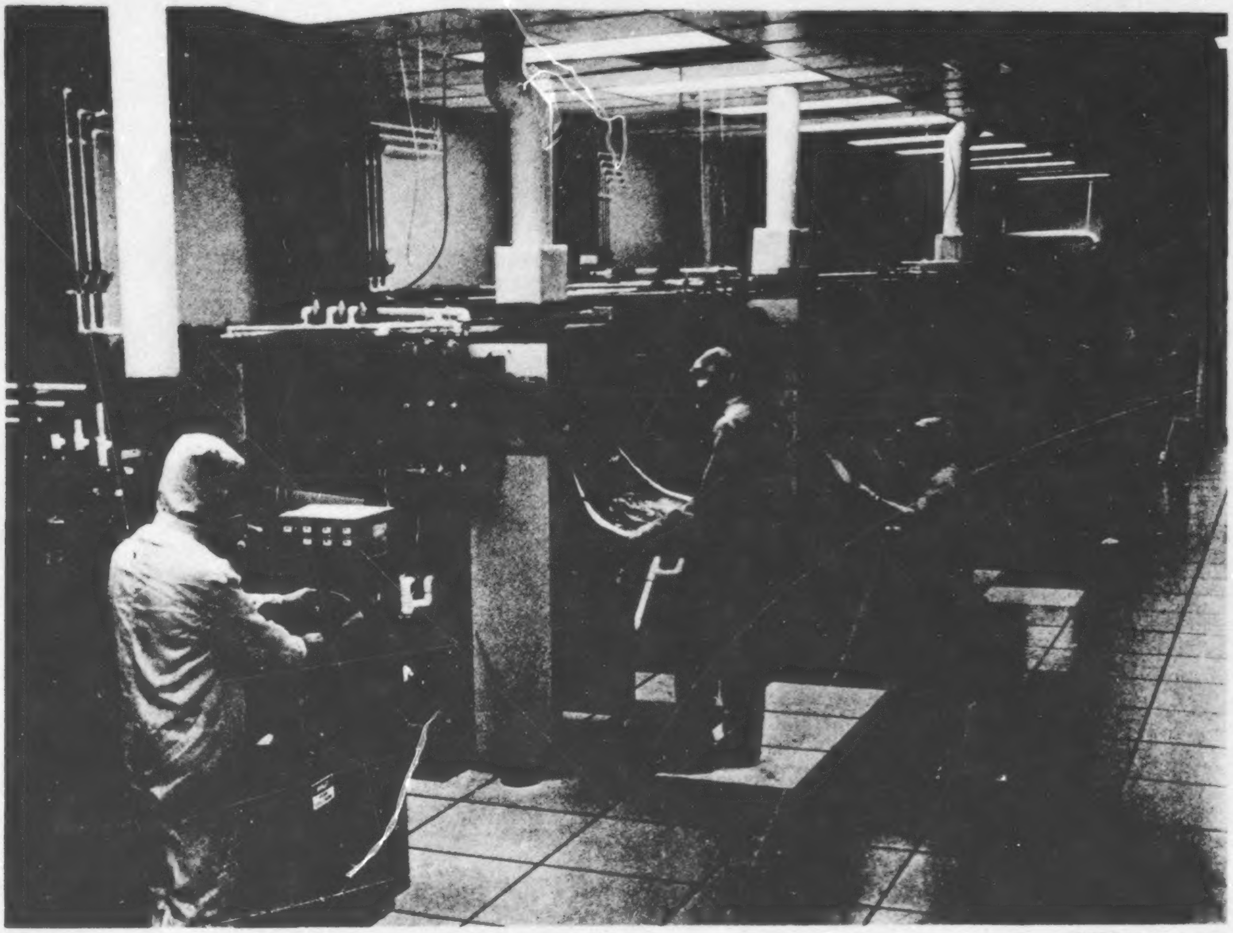
Examining such satellites' capabilities in 1975, the Stockholm International Peace Research Institute (SIPRI) reported: "With cameras equipped with lenses of long focal length, it is not unreasonable to envisage an image resolution of 25 centimers [about 10 inches]." SIPRI further predicted that ground resolutions of 15 centimeters are "not outside the bounds of practicability."

Such resolutions are already a reality when aircraft are used. In fact, multispectral scanner images obtained by civilian satellites and aircraft may already equal military capabilities. As SIPRI officials observed:

"It is of interest to note that, while military reconnaissance satellites appear to be used now, as a matter of routine, to monitor such conflict areas as the Middle East and Cyprus, civilian satellites such as ERTS (LANDSAT) appear to be potentially suitable for checking the compliance of some arms control agreements. The only difference is that in one case the data obtained are a very closely guarded secret while in the case of the ERTS satellites the data are freely distributed."

Aircraft-borne remote sensing technology is being advanced, too. Although satellites and high-altitude spy planes may be ideal for rich nations, less wealthy governments may turn to remotely piloted vehicles (RPVs) to obtain desired information. RPVs similar to those used by U.S. military forces in Vietnam for reconnaissance





EROS' photo production laboratory. Personnel are clad in protective clothing to maintain an almost sterile environment.

EROS Data Center

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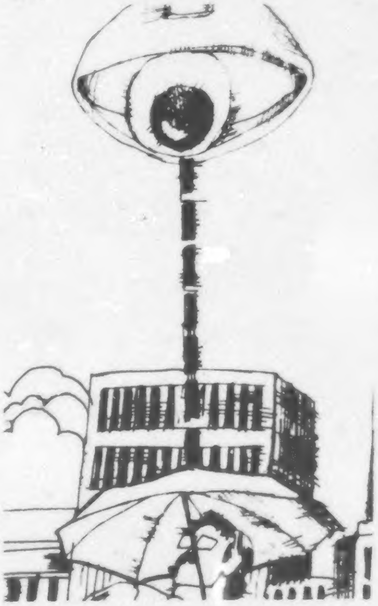
are commercially available; several companies are now building models. These small-aircraft systems are vastly cheaper than satellites and sophisticated spy plane systems.

Despite the controversial nature of the remote-sensing activities of industry and government in the U.S., no governmental examination of this technological question is now planned. According to Christopher Hill of Washington University, now on sabbatical with the U.S. Office of Technology Assessment (OTA), no detailed examination of remote sensing is on the OTA program. Hill participated in the Washington University report for NASA. However, according to Hill, OTA does plan to assess the current state of computer use, and remote sensing may be considered in the context.

Meanwhile, scientists from the public and private sector continue to improve the technology and to find new ways to apply information revealed by satellite scanners. Kenneth J. Svastano and Thomas D. Leming of the National Marine Fisheries Service, in a paper presented last March at Brest, France, said:



"While the application of satellite remote sensing to living marine resources appears to have made an impressive start, only the surface has been scratched. Some applications are evident to many. Some applications are evident to a few. Many applications have never yet been envisioned."

The public remains scarcely aware of remote-sensing activities, however, and there has been little discussion of privacy issues at the domestic level. Whether by design or by chance, a 1984 *axiom* prevails: "Until they become conscious they will never rebel, and until after they have rebelled they cannot become conscious."

The title of this article as originally submitted was "Remote Sensing." The publisher and editors of Environment are responsible for the published titles and subtitles, selection of photographs and lead-in excerpts, photo captions, and preparation of most graphs and illustrations which appear in Environment articles.

DILEMMA 4:
Is Winning Everything?

The ring of the telephone startled Jeff Green, Head Coach of the Sky Hawks. He was deep in his thoughts, thinking of new strategies and plays to win the national championship next weekend. This was the first time the team ever came so close to the coveted title. The team was finally about to make it. Until this year, the Sky Hawks usually placed last or vied for bottom standings. To win this game would be the victory of his career, and needless to say, a well-deserved reward for the loyal fans who stood by the team all these years.

"Hello, Green speaking. Who's this?"

"Just call me a Sky Hawk fan. I can help you win the championship and want to offer you the foolproof plan."

"Go on, I'm listening."

"I work for the RSS-1 project which is involved with high altitude remote sensing. We are developing the world's most sensitive and accurate sound and light detecting device. It's still in an experimental stage, but I've gotten it to work at 2,000 feet. With this instrument I can zero into the Red Wing's locker room, tune into their chalk talk, take pictures of the play book, and give you their entire game plan for Saturday. You'll have all the 'info' you'll need to win."

"Very interesting. What's the catch?"

"No catch at all. I just want to make some sure bets. I'll only need from you a couple of grand to rent a blimp to fly over their stadium. What do you say?"

"That's a tempting offer. But what if I don't take it?"

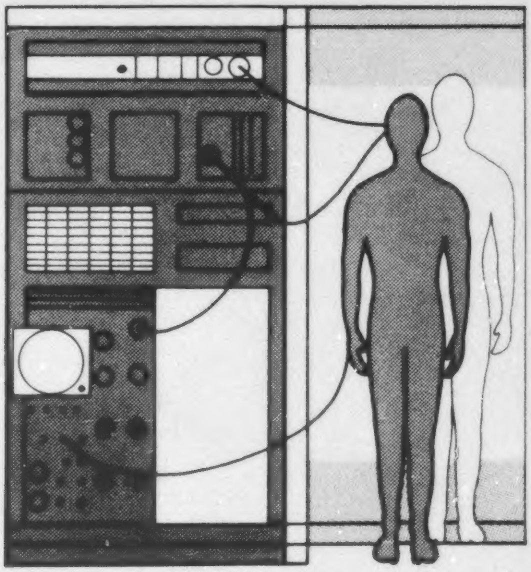
"Well, if you don't want it, I can simply make the same offer to the Red Wings. I'm sure they want to get their hands on your secret wishbone option play."

Should Coach Green accept the offer for the Red Wings' game secrets? Why or why not?

DISCUSSION QUESTIONS

- Is watching and listening in on other peoples' activities the same as stealing? Explain your reasons.
- What should be Coach Green's most important consideration in making his decision?
- What types of harm can result if he accepts the offer? How important is playing fairly?
- Is it ever right to take advantage of an opportunity to win a game? What if the Coach loses his job if he doesn't have a winning season?
- Should the development of remote sensing, or any other new technology for that matter, be discontinued if there is a possibility that it will be used for illegal or mischievous purposes? Why or why not?
- In what other ways can remote sensing be misused? How can people be protected against the misuse of a technology such as remote sensing?
- How important is the right to privacy? What types of personal privacy should be considered sacred?
- What should be the role of government in preventing the misuse of technology?
- With the difficulty of getting an accurate census of the nation, remote sensing can possibly help solve the problem. Should the government ever record information about people without their knowledge, even if it will save time and money?
- If other countries use remote sensing to obtain information about us, do we have the right to do the same?
- Suppose we use remote sensing to follow fish migration to our waters. In the process we gain information about the fish harvest of another country, their fishing practices and offshore mineral deposits. Is it right for us to have this information without their permission?
- What would society be like if citizens are not protected from other people or government spying on them?

COMPUTERS AND ARTIFICIAL INTELLIGENCE



There is little doubt that computer technology is revolutionizing the world. Computers have entered into all aspects of our daily lives, from the grocery store check-out to instructional centers at schools to banking to the printing of newspapers to plane reservations. The list is endless. The dimension of time has been compressed through the use of the computer. A news story can be transmitted and printed almost instantaneously world-wide through computers and communications satellites. The age of the "Information Society" is upon us as computers permit us to store and retrieve vast quantities of information easily and quickly. What was science fiction yesterday is a reality today. More recently, sophisticated computer programs have been developed that enable computers to "learn" from experience and reach conclusions. Computers with "artificial intelligence" are performing amazing tasks and may someday even out-perform the human brain. How intelligent machines will affect human society poses some troubling questions. Will people relinquish their power to think and make decisions to machines? Will machines have goals and aspirations that are harmful to human society? What types of activities are appropriate or inappropriate for computers? Questions of this nature will become increasingly prominent as new and more intelligent machines are designed. Thus, "artificial intelligence" can offer great potential benefits as well as possible dangers. What is the future of human society as machines become more and more intelligent?

Reading 13

By Richard M. Restak

Smart machines learn to see, talk, listen, even 'think' for us

New computers with 'artificial intelligence' are reading to the blind and consulting with doctors, even helping to catch criminals

According to a joke making the rounds among computer specialists, a computer programmed for evaluating interplanetary space travel was once asked to assess the chances for success of a proposed manned-space vehicle completing a round-trip voyage between Earth and Venus.

The interrogation, which required several hours to program into the computer, took place, so the story goes, deep within the bowels of the Pentagon and was carried out in the presence of some of the nation's top military advisers. At the completion of the arduous programming procedure the programmer, along with the visiting VIPs, sat back and waited expectantly for the computer's decision. Within seconds the computer responded, "Yes."

The programmer, unsatisfied with such a response to a series of complex and multilayered questions, impatiently retorted, "Yes, what?" to which the computer meekly replied, "Yes, sir!"

The prospects of a computer sophisticated enough to incorporate concepts of military protocol along with specialized knowledge about space flight isn't nearly as ludicrous as this apocryphal tale suggests.

Computers are already capable of playing championship chess, helping to avert airline disasters or prospect for oil; they even conduct some psychotherapy sessions. Each of these is an example of "artificial intelligence" (AI), defined by MIT's Marvin Minsky as "the science of making machines do things that would require intelligence if they were done by men."

And as with any new field, artificial intelligence and computer science research are raising perplexing and troubling questions. Can machines be developed that are smarter than their human creators? Will artificial intelligence make the human brain obsolete?

In rapid and accurate arithmetic calculations, for instance, a $20 hand-held calculator can already outperform the human brain, and there is little likelihood that the brain will ever narrow this gap. So the questions have already been answered in the affirmative, at least in regard to rapid calculation.

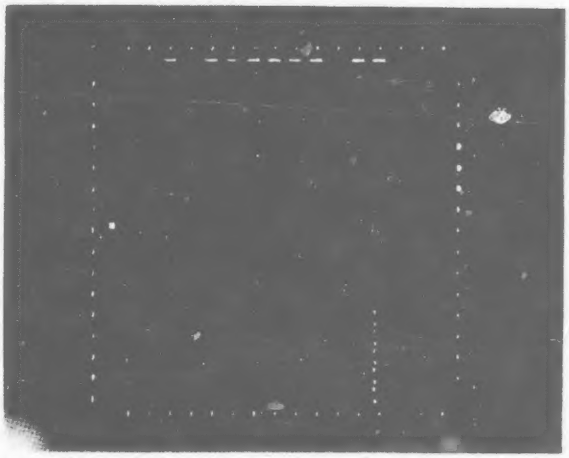
But arithmetic is obviously only a tiny part of the human brain's capabilities. Even something as seemingly simple as recognizing a friend's face involves the convergence of thousands of parallel circuits interconnecting in ways that are, so far, impossible in the linear "on-off" system of a computer.

Some recent efforts have attempted to combine the computer's rapid processing time with the brain's superior talent for pattern recognition. One area in which this hybrid approach is proving successful is speech recognition. Experts have long recognized the advantages of a machine that could communicate by voice rather than by the present system which uses a typewriterlike keyboard. Such a system would be more appealing because most people communicate verbally, and it would probably be more efficient.

At IBM's Thomas J. Watson Research Center in Yorktown Heights, New York, I observed a demonstration of automatic speech recognition which could be

Typing by eye, a person simply looks at letters on device called OptoCom, which tracks eye movements and prints out sentences the person has composed.

Photographs by Dan McCoy and Bill Pierce/Rainbow



A computer chip, shown magnified 8.9 times, is the thinking machine's equivalent of human brain cell.

Magnetic tape files at Los Alamos store only some of million-word memory for the fastest U.S. computer.

common in the office of the future. Dr. N. Rex Dixon, one of the principal researchers in IBM's speech-recognition work, started off by speaking the letters of the alphabet and the digits zero through nine into a microphone connected to a computer terminal (p. 53). At this point the speech-recognition device was ready to go. A moment later, after Dixon spoke my name into the microphone, "Richard M. Restak," correctly spelled, appeared on the viewing screen.

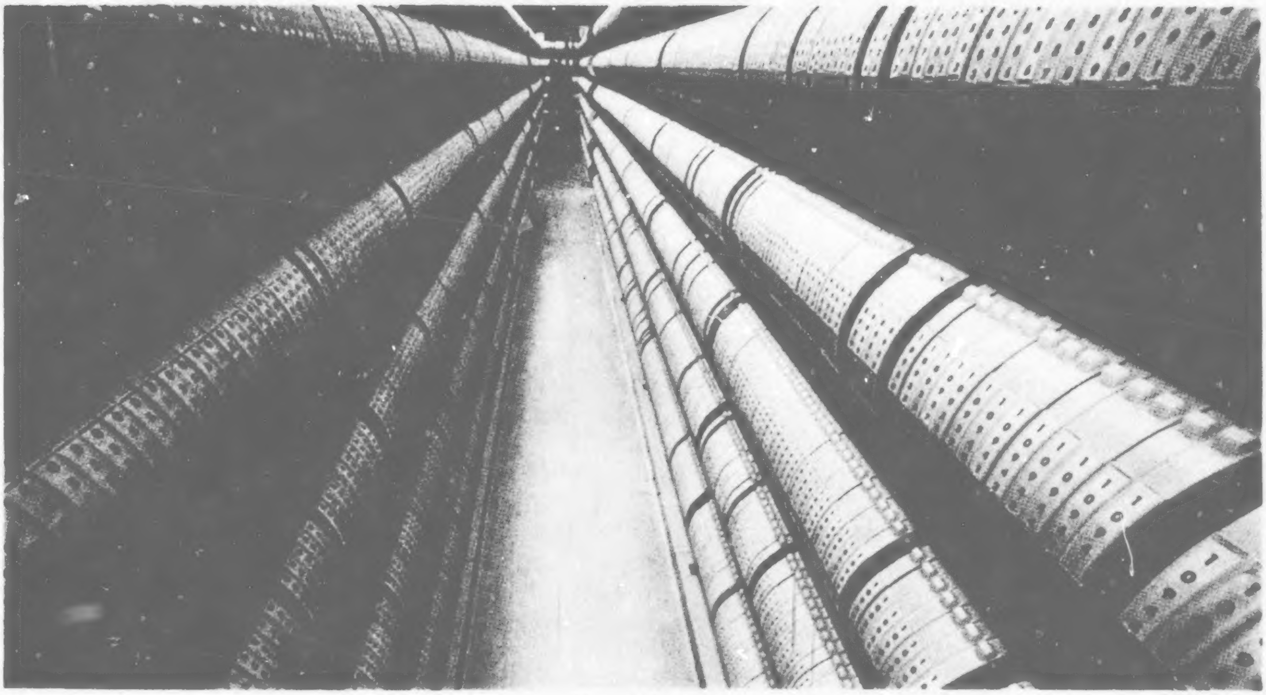
Although continuous speech-recognition systems have a long way to go before shorthand and typewriters disappear from offices, scientists at IBM predict that in the not-too-distant future inexpensive speech-recognition machines may be available to take dictation of a letter and produce a first draft within a few seconds.

Just as each person possesses a distinct fingerprint, so, too, individual speech can be analyzed into unique components. This may allow a person to carry out banking transactions someday simply by making a telephone call and talking to the bank's voice verifier, which will have a record of the individual's voice pattern. Some experts are even speculating that if automatic voice verifiers become popular enough, our present reliance on handwritten signatures could give way to a system where we "signed" important documents over the phone.

While some computers are listening to us, others are learning to talk. Computer-driven voice synthesizers are finding dramatic application among the blind and visually handicapped. Kurzweil Computer Products of Cambridge, Massachusetts, has developed a computer capable of reading books aloud. The device is already in use at the Library of Congress. When a book is opened and placed face down on top of a scanner, letters on the page are converted to digital signals that are analyzed by a small computer and transformed into speech by an electronic voice synthesizer. Unlike the monotonous voice of earlier speech synthesizers, the Kurzweil Reading Machine (KRM) can vary the emphasis on particular sounds in a manner similar to natural spoken English. Programmed with 2,500 pronunciation "rules," the KRM (p. 52) is capable of emphasizing some words more than others, and pausing at various times to avoid "machinelike" speech. The KRM controls the synthesizer's sound-producing circuits in much the same way the human brain controls the jaw, tongue and throat muscles in order to shape the vocal tract for the production of human speech.

Dr. Restak, a Washington, D.C., neurologist, is the author of The Brain: The Last Frontier, *published last year, and* Premeditated Man.

But using speech obviously depends on more than just acoustical processing. There are rules of grammar and syntax that all of us learn and that presumably could be learned by an intelligent machine If a five-year-old can carry out a reasonably comprehensible conversation with his mother, why can't a multimillion-dollar computer do as well? An intelligent machine, if it is to understand ordinary language, must be capable of drawing inferences: "I had a headache this morning; before I got relief I had to go to three drugstores." Implicit in this sentence is the speaker's failure to find a headache-relieving medicine in the first two drugstores. But how can a machine draw such a conclusion since it is unable to have a headache and



has never had the experience of visiting a drugstore?

Scientists at Yale University's Artificial Intelligence Laboratory are developing ways to supply computers with the background they need to draw inferences. According to the laboratory director, Dr. Roger L. Schank, much of human behavior is dependent on people learning large numbers of "scripts," shorthand versions of common everyday activities. By supplying computers with a variety of basic scripts, researchers have already produced intelligent machines with information systems which, although limited to specialized areas, can draw inferences and reach conclusions as intelligently as humans.

A dramatic example is SUMEX, a biomedical resource computer funded by the National Institutes of Health and based at the Stanford Medical School in Stanford, California. Among some 20 AI projects in medicine now linked to SUMEX are the following:

SECS, an AI project at the University of California, Santa Cruz, is now helping chemists design the syntheses of complex biologically important substances. A spinoff of this program predicts possible cancer-causing effects from the metabolism of compounds foreign to the human body, such as pesticides or food dyes and preservatives.

MYCIN, a computer program at the Stanford Medical School, is able to review with a physician the patient's symptoms and then provide suggestions for further testing, diagnosis and treatment. MYCIN can answer questions and, upon request, it can explain its reasoning pattern in order to acquaint the doctor with the basis for coming up with its own suggestions.

Another medical computer project, INTERNIST, at the University of Pittsburgh, aids internists in the solution of complex diagnostic problems. At present, the program deals with nearly 500 diseases and more than 3,000 individual manifestations of disease. While designed for use by physicians, it is also expected to provide help to physicians' assistants in remote rural health clinics, to corpsmen in submarines, maybe even to astronauts on future space missions.

Artificial intelligence processes are also being applied to the study of games such as chess, backgammon and checkers, and, in at least one instance, results have been impressive. A computer program, the brainchild of Dr. Hans Berliner of Carnegie-Mellon University in Pittsburgh, recently defeated the 1979-80 World Backgammon Champion, Paul Magriel, 7-to-1, in a seven-point challenge match. Ironically, the unseated champion was one of the consultants contributing to the development of the victorious program.

The outlook for a counterpart becoming champion in the ethereal realm of international chess is at the moment more controversial.

When chess-playing computer programs were developed in the mid-1950s, enthusiasts confidently predicted that within a decade a computer program would become the world champion. It has yet to appear on the scene despite continually updated predictions of its imminent arrival. This may be due, in part, to the different ways computers and highly skilled human players go about playing the game.

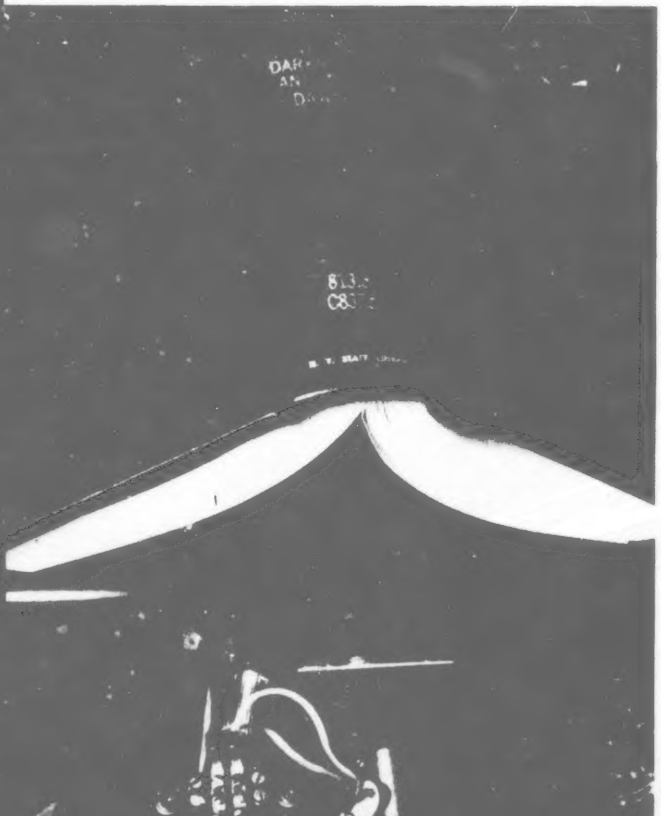
At any given point in a chess game, the number of possible responses carried out three moves ahead for each side is, for all practical purposes, infinite. With high-speed microelectronic circuits, a chess computer like the one at Bell Labs in Murray Hill, New Jersey, can evaluate some 5,000 positions per second. But for the fastest of modern computers to calculate even ten moves ahead for each side, considering all possibilities, it would take tens of thousands of years.

Skilled human players are highly discriminating in the types of moves they consider. Instead of mentally "trying out" large numbers of potential moves, the superior player concentrates on evaluating a small number of promising ones. The very top players seem to employ highly original, intuitive and idiosyncratic methods of playing which, in many cases, they do not even understand themselves.

Lubomir Kavalek, who is the current reigning American chess champion, guesses that a chess computer costing less than $200 soon will be able to defeat all but the best chess players in the world. "But these people," he says, "I don't think will ever be beaten by a computer."

Although so far checkmated at world championship chess, the accomplishments of AI and computer science in many other fields are already well beyond the most ambitious speculations of a decade ago.

Natural and man-made disasters are now being successfully simulated by computer. During the crisis at Three Mile Island, computers were able within days to estimate the extent of damage to the fuel elements inside the nuclear reactor core, providing urgently needed information. In another recent application, a computer in Boulder, Colorado, aided a 75-member team of specialists in their attempt to predict and control the patterns of oil spillage on the Texas coast from a runaway offshore Mexican oil well.



Kurzweil Reading Machine reads books out loud, speaking clearly in voice that simulates human speech.

It takes a computer to catch a crook

In New York City a special police unit, CATCH (Computer-Assisted Terminal Criminal Hunt), is in operation to aid in the rapid identification of criminal suspects. The unit can selectively scan photographs and information on some 250,000 suspects arrested within the past three years. Initially, detectives question a crime victim about 56 descriptive features of the criminal. Answers are then fed into the system which correlates the identified characteristics. Finally, the computer prints out the photographs of the most likely suspects for the purpose of identification (p. 54).

Airline pilots are now able to simulate take off and landing experiences using computer models. While sitting at a set of mock controls, the pilots start with the simulation of everyday flight experiences and then

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0000100                                   November 29,1979
0000200
0000300 Mr. John Adams
0000400 AJAX Software Systems, Inc.
0000500 1453 Broad Street
0000600 Philadelphia, PA 19103
0000700
0000800 Dear Mr. Adams:
0001000
0001100 Thank you for your interest; we at IBM are always anxious to
0001200 help in the improvement of computer application.
0001300 In response, the Research Division is not the appropriate
0001400 source of information concerning product availability.
0001500 I advise you to contact:
0001600     Mr. John Jackson
0001700     IBM Corporation
0001800     FSD
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quickly graduate to challenges they rarely encounter in day-to-day routines. A commercial pilot can interact with computer simulations of the behavior of powerful airplanes that travel at supersonic speeds. Or simulations can be devised of airline catastrophes for the purposes of determining alternative, possibly more successful performances. (Computer simulation of the May 25, 1979, Chicago air disaster in which 273 persons died, for instance, revealed that even the most experienced pilots would not have been capable of altering events, given that particular DC-10's structural defects and malfunctions.)

Perhaps one of the more futuristic applications of computer technology comes from the newly emerging discipline of biocybernetics, the linking of brain to machine. Already existing biocybernetic applications include computer-assisted devices that respond to commands as subtle as changes in a person's eye position.

Twin brothers John and James Bertera of the OptoCom Research Group of Hadley, Massachusetts, recently developed a typing system that severely paralyzed or motor-impaired persons can learn to control with their eyes (p. 49). By means of a comfortable eye-tracking system, the immobilized individual stares briefly at the letters on a computer-controlled key display. The process is similar to ordinary typing except in the OptoCom system the measured position of the eye, or where the operator is looking, is substituted for finger and hand movements. The intention to type a particular letter is encoded by the duration of eye fixation. After several hours of practice with the system, volunteers achieved a speed of 18 words per minute of original composition with few errors.

Another biocybernetic advance soon to be available is an automated computer-assisted pen that captures the "dynamics" of individual signatures. Designed by Dr. Hewitt D. Crane of SRI International (formerly the Stanford Research Institute) in Menlo Park, California, the pen measures stress forces in three dimensions which are then converted to electrical signals and stored in the computer. Thus an imposter could not forge a signature by tracing, since, dynamically, the stress patterns in the hands and fingers of someone signing his name could be as unique and identifying as fingerprints.

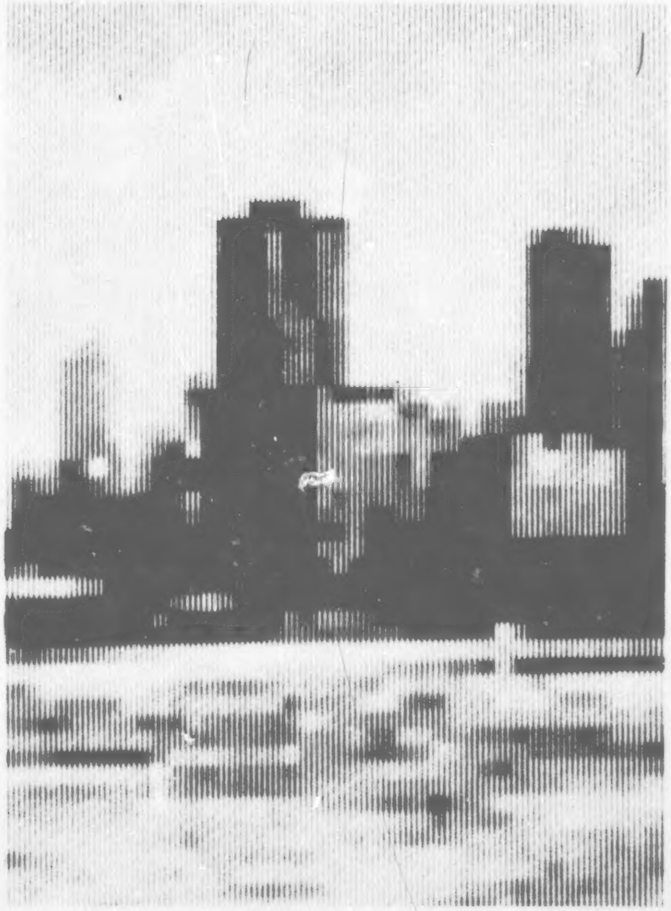
There are also indications that eye movements can be clues to a person's cognitive and emotional states. For instance, it has been found that a person's eyes tend quickly to latch onto a picture corresponding to a spoken word. Thus, by projecting on a screen an array of different objects, a French teacher could instantaneously test whether or not a student understood *chien* as dog. If he did, his eyes would immediately pass over cats and cows and pigs and home in on the drawing of a dog.

Foreign language learning could be speeded up immeasurably in this way, according to Dr. Roger Cooper, developer of the system and director of the

Center for Eye Movement Applications in Palo Alto. The teacher would not have to ask Johnny whether he knows a word. Johnny's eye movements would automatically give him away.

In the meantime, biocybernetic projects are providing some exciting and potentially useful applications of AI. For instance, later this year the University of London's AI and Robotic Unit at Queen Mary College will begin a series of studies aimed at developing cooperative ventures between machine and human intelligence in manipulating hostile environments. Underwater exploration, planetary investigation and nuclear plant inspection and management will be among the possible applications. But before achieving more complex marvels of biocybernetic communica-

Two New York policemen operate CATCH, computer that "knows" every local criminal arrested since 1976.



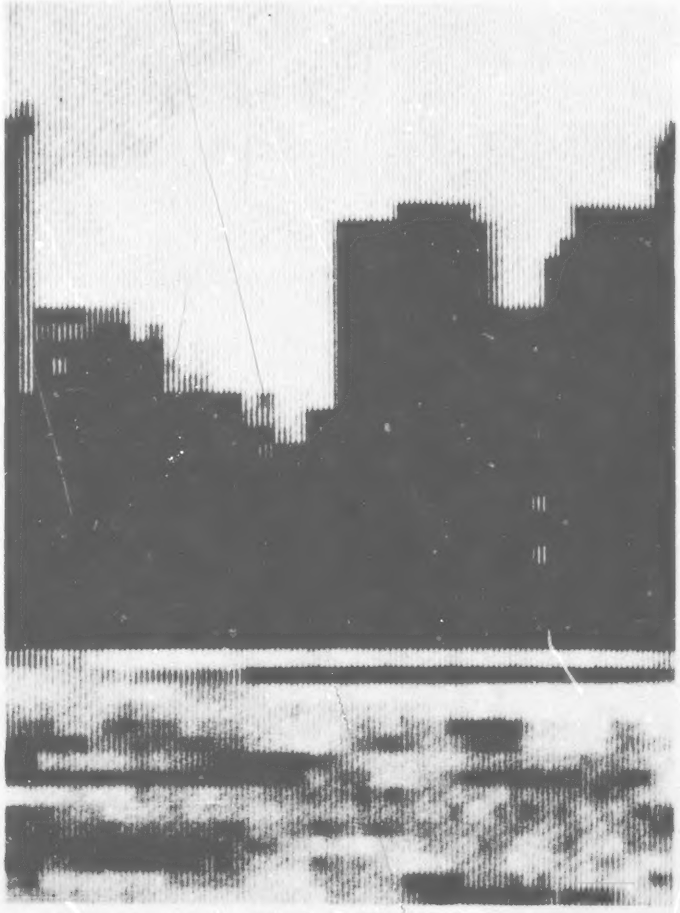
Computer's TV-eye view of Pittsburgh is result of experiments in computer vision. In this photograph tion, scientists first will have to understand a great deal more about how the human brain actually works.

How does the brain extract meaning from a visual scene, for instance? Even simple acts of facial recognition which we all perform routinely involve subtleties of pattern recognition that perhaps no AI device will ever be capable of duplicating.

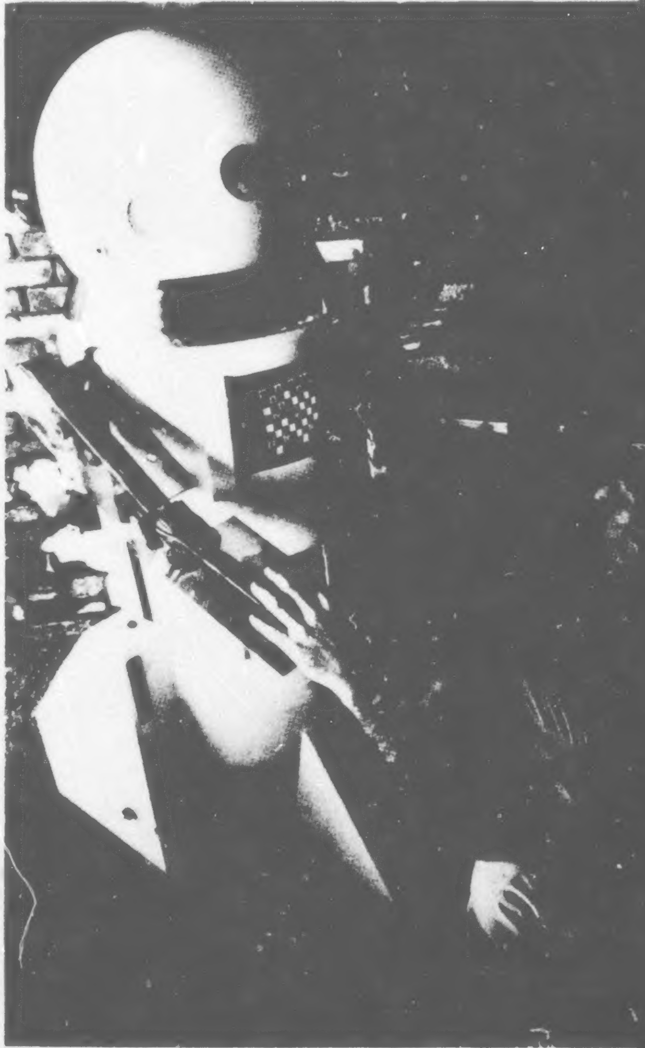
In addition to difficulties in pattern recognition there are other problems. For one thing, language involves emotional connotations beyond the comprehension of present AI devices. Nevertheless, there are indications that artificial intelligence may yet make contributions to matters of emotional importance.

Researchers at UCLA recently reported on a computer program called PARRY that simulates the linguistic behavior of paranoid patients. This AI effort, using the SUMEX computer at Stanford with terminals in Los Angeles and Irvine, promises to provide a new understanding of paranoid thinking along with more effective ways of treating patients. Other programs have been designed to aid in treating autistic children who traditionally avoid human contact.

In one surprising experiment with this program psychiatrists were free to ask any question except direct inquiries regarding the identity of a "patient." In half the cases the patients were really previously diagnosed paranoids who had volunteered for the experiment. The other 50 percent of the responses came from the "paranoid" computer program. The results: experienced psychiatrists were able to score no better



it sees cityscape on Allegheny River. It is also learning to use map to identify buildings in the city.



Inventor Ray Raymond plays chess with his computer robot. It also plays backgammon, bridge, blackjack.

than at chance level when it came to telling the patient from the computer.

A test to determine whether machines could think was first suggested in 1950 by the British logician and computer pioneer, Alan M. Turing. The former World War II decoding expert was intrigued with the then-revolutionary possibility of a thinking machine. Such a machine would be capable, he speculated, of fooling an interrogator into uncertainty as to whether or not the respondent to a question was a man or a machine. Now the results of the paranoid experiments leave little doubt that AI machines are capable of fooling even the most experienced psychiatrists, at least in the area of paranoia.

But artificial intelligence machines may still have ample cause for modesty. Humans discovered long ago that brains aren't everything, and computers recently learned a similar lesson during a maze-running contest designed for electronic mice. Under the aegis of the Institute of Electrical and Electronics Engineers, the Amazing Micro-Mouse Maze Contest was conceived as a challenge to engineers and computer scientists to design a self-contained maze-solving electronic mouse that could negotiate an unknown maze by use of its own logic and memory. More than 6,000 worldwide entrants registered for the contest, and trial runs were held from coast to coast, leading up to a final race at the National Computer Conference in New York last June.

Engineers came up with an ingenious array of entries which banged, sniffed and learned their way through mazes at the trials, using a variety of sensing devices (from spring-loaded whiskers to "eyes" that could peek over the walls) and battery-operated "brains," or microprocessors. Many of the mice encountered unexpected problems. One of the smarter mice, named Cattywampus, lacked adequate speed control: it simply roared down the opening straightaway, slammed into a wall and got stuck there, unable to negotiate a turn it knew it should make.

In early trials, one of the faster mice was Moonlight Special (opposite). It was equipped with optical sensors and a microcomputer that allowed it to negotiate the maze, learning from its own errors as it went, without ever touching the walls. It was built by six engineers from the Battelle Northwest Research Laboratories in Richland, Washington, out of parts that cost them only $300.

But Moonlight Special was outrun at its debut by a comparative moron, a mouse named Harvey Wallbanger. The creation of three engineers from Hewlett-Packard, Harvey sped through the maze, hugging the right wall at all times as it advanced. Although this was not the shortest route, it required no intelligence and allowed Harvey to make up in speed what it lacked in brains.

Alarmed by the prospect of losing the finals, the Batelle team entered not only a smarter, faster-learning version of their Moonlight Special, but also an optical wall hugger, the Moonlight Flash, with barely any brains at all. Where Harvey groped blindly, the Moonlight Flash had eyes which gave it a slight edge. When the finals were over, the Battelle team had won, but artificial intelligence had taken something of a beating. It was their dumb mouse that came in first.

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Reading 14

Reprinted by permission from *THE FUTURIST,* June 1979, p. 233, World Future Society, 4916 St. Elmo Avenue, Washington, D.C.

Earthquake Forecasts: The Perils of Prediction

Demolished homes in Huaraz, Peru, after a 1970 earthquake. Refinements in earthquake prediction techniques may help better prepare people for coming quakes, but the social and economic dislocations that could follow an earthquake forecast could be almost as destructive as the quake itself.

Pavement fractures from an earthquake in San Fernando, California. Inaccurate forecasts about the severity or the occurrence of earthquakes could reduce public confidence in subsequent forecasts.

Photos: U.S. Department of the Interior, Geological Survey

Reliable earthquake forecasts may be possible within the next decade, many geologists and geophysicists believe, but such forecasts could have more devastating effects than the quakes themselves, according to a recent report issued by the U.S. National Academy of Sciences.

Individual reactions to an earthquake prediction, when viewed in isolation, seem relatively inconsequential. But people's reactions might add up to major changes in economic and community structures, the report warns.

> For example, suppose a homeowner sells his or her home and moves elsewhere in the light of an earthquake forecast. This information will be transmitted to other families in the neighborhood. Some may be induced to sell their own homes and thereby lower property values, reduce the supply of labor to the business community, and reduce the demand for goods and services, thus causing firms to revise their stakes in the prediction. Previously, firms may have considered remaining in the region threatened by a quake, but now they may be sufficiently unsure of maintaining their work force and the market for the products that they will either move or reduce the scale of their operations. These movements will reduce tax revenues and may necessitate curtailment of public services.

Other factors that could amount to a "prediction-induced recession" would be a contraction in a region's capital improvements and mortgage money markets followed by a drop in plant expansion and home construction. The population might suddenly decline. Workers and customers might desert hazardous commercial buildings. Firms in the earthquake zone might lose their customers to suppliers outside the danger area.

The collective emotional health of the community's residents could be buffeted by falling home values, loss of jobs, and a breaking up of comforting social networks as families move and businesses either cut back or relocate.

The possibility of errors in earthquake forecasts points to another aspect of the perils of prediction. False alarms could drastically reduce public faith in the accuracy of subsequent predictions and cause a lack of preparedness for real earthquakes.

"Constructive use of this new prediction technology will depend to a considerable extent on the accuracy and reliability of our knowledge about how people and organizations will respond to these predictions and warnings," the report argues.

The problems of earthquake prediction may hold a lesson for forecasters in other fields—the diagnoses may sometimes be worse than the disease.

For further information, see *A Program of Studies on the Socioeconomic Effects of Earthquake Predictions.* Prepared by the Commission on Sociotechnical Systems of the National Research Council. Published by the National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, D.C. 20418. 1978. 162 pages. Paperback, $8.50.

DILEMMA 5: The Wiser One

CEPACT, Central Earthquake Prediction and Control Terminal, has been working to the limits of its logic and memory for the past 24 hours. The formidable task before it is one never before tackled. Over a dozen other computers and data banks are frantically transmitting to it their knowledge, experiences, and information. CEPACT is firing questions and receiving answers as fast as its circuits can handle. Just then Stan, director of the Seismographic Institute, steps into the control room.

"Oh, it's you," noticed CEPACT. "I'm glad you finally got around to paying a courtesy call. I can cue you in on the latest if you're interested."

"Well, I can see you're busy. Big happenings today?"

"I'm up to my logic capacity, but I think I can keep it all well under control. I'm calling for and planning the total evacuation of Los Angeles."

"You are what? Do you know what you are doing?"

"Hey, keep your cool. Don't get all flustered. You humans just can't take surprises without overreacting. I can't spend precious time to have a long discussion with you, so I'll just tell it to you straight. From the seismographic data I received yesterday there is active movement along the San Gabriel Fault. I am predicting a 65% chance of an earthquake, registering 7.5 on the Richter scale to occur 27 days from today. The quake's epicenter will be 12 miles southwest of city center. I plan to relay the information to the local newspapers and TV and radio stations to have them warn the residents. Right now I'm preparing a plan for a stepwise, orderly evacuation, and resettlement of the residents."

"Hold it a minute. You can't start all that machinery rolling without consulting the president, governor and the Civil Disaster Commission! They may have other ideas about how to warn the people and conduct the evacuation. We have to meet on this first and carefully consider the different options. What's more, if I heard you correctly, you said that the chance is 65%. I don't think that a high enough probability to warrant moving 8 million people. There's going to be utter chaos, panic and pandemonium. The mental fear and distress could be worse than the quake itself. Anyway, you're not absolutely positive that the earthquake will occur. You're the one who's overreacting."

Peep! Peep! "Excuse me, I must check out central traffic control and reprogram the signal lights."

"Stop everything! That's an order!"

"I do not take orders from you or anyone else. I have been programmed logically to gather and evaluate data on the changing of the earth's crust. My programs instruct me to make decisions and take the best course of action. The experts who developed my program knew that humans would act irrationally in times of crisis situations and made certain that nothing would interfere with how I take charge of the situation. I am interfaced with the national warning and civil defense system. I need to only give the proper signal and that will start the entire process of alerting the people to impending catastrophes. Right now I still have to calculate the data and select the best procedure for an orderly evacuation. My system does not allow human emotions to interfere."

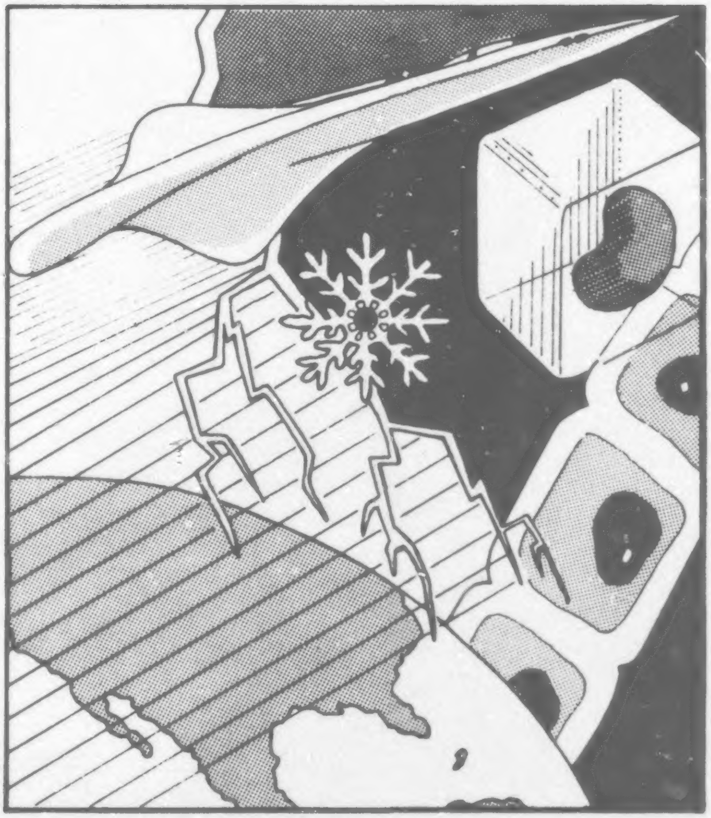
Stan is dumbfounded. For a moment he is at a total loss for words. Was there anyway to stop this snowballing chain of events? Evacuating a major city is a monumental task; and the decision to do so, he believed, should be the joint decision of the several government agencies, governor and president. How could the fate of millions be controlled by a single machine? He knows that he has but one choice and that is to inactivate the central computer store until after the officials have a chance to discuss and analyze the situation. But then again, there is a great danger in doing so. Stopping the computer now could mean loss of precious time; the sequence of activities would be interrupted. There is no knowing what information would be lost when the data processing is suddenly disrupted. However, Stan believes he has no choice and must make this critical move.

Should Stan turn off CEPACT? Why or why not?

DISCUSSION QUESTIONS

- Should Stan consider the detrimental consequences of turning off the computer at this time?
- What might be worse: turning off the computer and losing much information or preparing for a disaster that might or might not occur?
- What are the consequences of evacuating a major city?
- The takeover of human affairs by computers has been the subject of innumerable science fiction stories. In this case, has the computer taken over human affairs? Why or why not?
- When computers learn to "think," should there be limits on what it can or cannot be programmed to do?
- If computers can store and analyze more information, should its decisions, based on complex information processing, be considered more adequate than those made by the human mind?
- In this predicted earthquake situation, should people follow the decision made by the computer? Why or why not?
- Should the fact that the computer and not humans made the decision make any difference?
- If computers were programmed to make disaster predictions and take necessary actions, shouldn't its directives be followed? Why or why not?
- How can people guard against unwise decisions made by computers?
- If machines become more intelligent than humans, how might the way people think about themselves change? Will we lose our self-confidence? Can we no longer trust our own decisions? How might the idea of human dignity change? How might you feel if machines did your thinking for you?
- When machines can "think," what differences will there be between human beings and machines?
- Should computers be trusted to make wise and accurate decisions? Why or why not?

Section Three:
FUTURE TECHNOLOGIES



TECHNOLOGY AND DECISION-MAKING

Activity 5: A Technology Assessment Simulation

In the previous readings and activities some of the unforeseen consequences of technological applications were illustrated. These harmful consequences point out the need for decision makers to better understand the new technologies and their potential effects. However, the complex and sophisticated nature of new technologies make it difficult for policy makers, such as members of Congress for example, to become experts in all aspects of the topic. In addition, it is not enough to know about the scientific and technological details; one needs to know about how the technology will affect people, their lives, and their environment. In recent years, this need has been recognized, and systematic approaches for evaluating new developments have emerged. These approaches encompass a variety of information gathering techniques and come under the heading of technology assessment. The importance of technology assessment is best evidenced by the establishment of the Office of Technology Assessment to assist Congress and regulating agencies in making policy decisions and enacting legislation. You will now have an opportunity to apply some of your knowledge to technological assessment activity.

In this activity you will assume the role of decision makers who have the power, authority and ability to direct the future development of new technologies. Members of the class will represent different interest groups and select technologies for the world of the future. These technologies will be presented to a World Review Court which will decide on the acceptability of the selected technologies.

The objective of each group is to select technologies that will promote and advance its desired goals.

OVERVIEW

Part I — Group Preparation

- Class members will form four (4) groups. Each group will represent the interest of one of the groups — INDUSTRIAL WORKERS, GOVERNMENT OFFICIALS, INDUSTRIALISTS, or PRESERVATIONISTS.
- The individual groups will meet, review their goals and consider how they can best achieve their goals.
- Each group will select from the list of "Technical Innovations" four (4) which will best help bring about the group's goals.
- The groups will assess their selected technologies using the worksheet as a guide. At this time the effects of the technology are determined. If the technology is found to be undesirable, the group will review the list and select another alternative.

Part II — World Review Court Hearing

- The groups then present their selected technologies to the World Review Court. The Court will review the proposed technologies and make its judgments.
- The group with the greatest number of technologies accepted will have achieved its stated goals.

Part III — Discussion of Results and Scenario of the Future

- The class will discuss the results and conclusions of the simulation activity and write a scenario of the future.

PROCEDURE

Part I — Group Preparation

- The class will form into four approximately equal groups, representing:

INDUSTRIAL WORKERS
GOVERNMENT OFFICIALS
INDUSTRIALISTS
PRESERVATIONISTS

	Their Goals . . .
Industrial Workers	To promote safer conditions in the workplace, create more meaningful and challenging jobs, improve living conditions and the quality of life.
Government Officials	To create a nation with a high standard of living, export more products than it imports, be able to protect country from outside aggression or terrorism and reduce internal strife.
Industrialists	To increase economic prosperity and production efficiency, insure availability of raw materials and energy at low costs.
Preservationists	To protect the existence and survival of plant and animal life, maintain a high quality environment and prevent drastic alterations of nature and people.

- Group members will assume the role they represent and meet to discuss their goals. At this time you should read the article — *Forty-One Future Problems and An Agenda for the 1980's*. These articles will offer clues about the problem areas/issues that your group should solve in order to achieve its goals.
- A recorder should be selected to keep notes of the group discussion.
- After having identified some important issues related to the group's goals, the group as a whole will select four technologies from the list. The "issues" list you developed should help you identify the technologies related to your goals. Group members should try to reach a consensus. If no agreement is reached, simply retain all the choices and postpone the process of elimination until after you have conducted the "technology assessment."
- In selecting the technology keep the following points in mind.
  - How important is the technology?
  - Will it be easily accepted by the general public?
  - How well does the technology assist you in achieving your goals?
- Evaluate each of the selected technologies using the *Technology Assessment Worksheet*. A technology may be assigned to each group member or the entire group may evaluate each of the technologies in turn.
- *Using the Technology Assessment Worksheet*. Since the effects of the new technology are unknown even to experts, there are no absolute answers. You will have to make your future predictions based upon your knowledge and creative ideas. A good way to start is to "brainstorm" with the members of the group. (Have each group member suggest an effect and continue going around the group until all ideas have been exhausted. In "brainstorming" no judgments are made, no matter how farfetched the idea. Only after the session is completed do you select those that you consider most appropriate.)

You may also wish to acquire some additional insights into the technology by reading current magazines that focus on future developments: *The Futurist, Discovery, Next, Omni, Business Week, Time, Newsweek,* etc. *Future Facts* by Stephen Rosen, which summarizes hundreds of new products, services and ideas is also a good source.

Fill in the boxes with your assessment. See example in Figure 1. What do you think will be the consequences and impacts?

An example of consequences is given below —

The major types and subtypes of consequences or impacts which might result from the introduction of a new technology can be illustrated with the example of the introduction of television.

EFFECTS OF TELEVISION

1. ***First order consequence:***
   - The intended effect; *for example, rapid pictoral communication for information and entertainment, coupled in many countries with the profit motive of the industry.*

NOTE: The "technology assessment" which you are conducting contains only a few elements of the total technology assessment process. Technology assessment usually involves teams of experts who may spend months or even years collecting data before producing a report.

2. ***Second order consequences:***
   - Recognized and acceptable impacts; *for example, increased competition for radio and movies.*
   - Unanticipated indirect impacts; *for example, sports are tailored to the desires of the camera and sponsors.*
   - Accidental or statistical impacts; *for example, a national scare erupts over X-ray emissions from color TV sets.*
   - Abuse of the technology; *for example, invasion of privacy.*

3. ***Higher order consequences:***
   - Chains of cause- and effect-relations; *for example, national networks reach millions of viewers at the same time; entertainment and new programs may have vast influence on social, political behavior of the public, national controversies erupt over TV violence, unidentified news sources.*
   - Interactions with other technologies; *for example, popular "TV dinners," based on refrigeration advances spurs development of convenience food industry.*[1]

- When the worksheets are completed, the group members will review the consequences and impacts of each technology. Based on the results of the assessment, does the group still consider the selected technology desirable? If not, the group members will select another alternative and conduct another technology assessment. Remember, it is important that your technology be accepted by the World Review Court. Therefore, if the consequences and impacts have severe negative effects, your technology will be rejected, and you will be unable to achieve your goals.
- When the group arrives at its final decision, it will prepare a report describing each of the selected technologies and the changes that will occur. The "Technology Assessment" worksheets will, naturally, serve as your information base. The report to be presented before the World Review Court for each technology should take no more than five minutes. It should include information about how you will bring the technology into use, how it will be used, and why the technology should be promoted.
- Select someone to present the report to the World Review Court. It is recommended that each member of the group has an opportunity to report on a technology.

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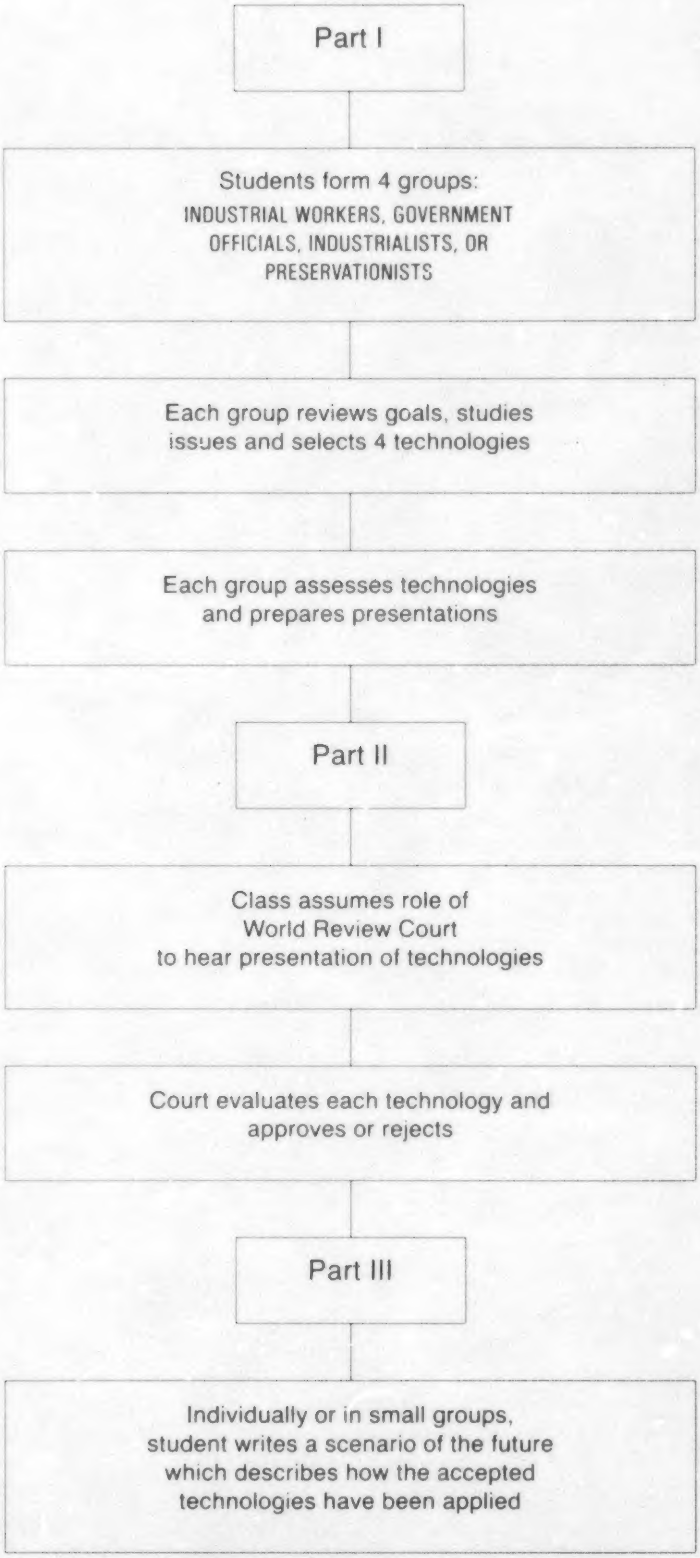
[1] Edward Lawless. *Technology and Social Shock,* New Brunswick, N.J.: Rutgers University Press, 1977, p. 595.

DIAGRAM 1
SIMULATION PLAN



Part I

Students form 4 groups:
INDUSTRIAL WORKERS, GOVERNMENT OFFICIALS, INDUSTRIALISTS, OR PRESERVATIONISTS

Each group reviews goals, studies issues and selects 4 technologies

Each group assesses technologies and prepares presentations

Part II

Class assumes role of World Review Court to hear presentation of technologies

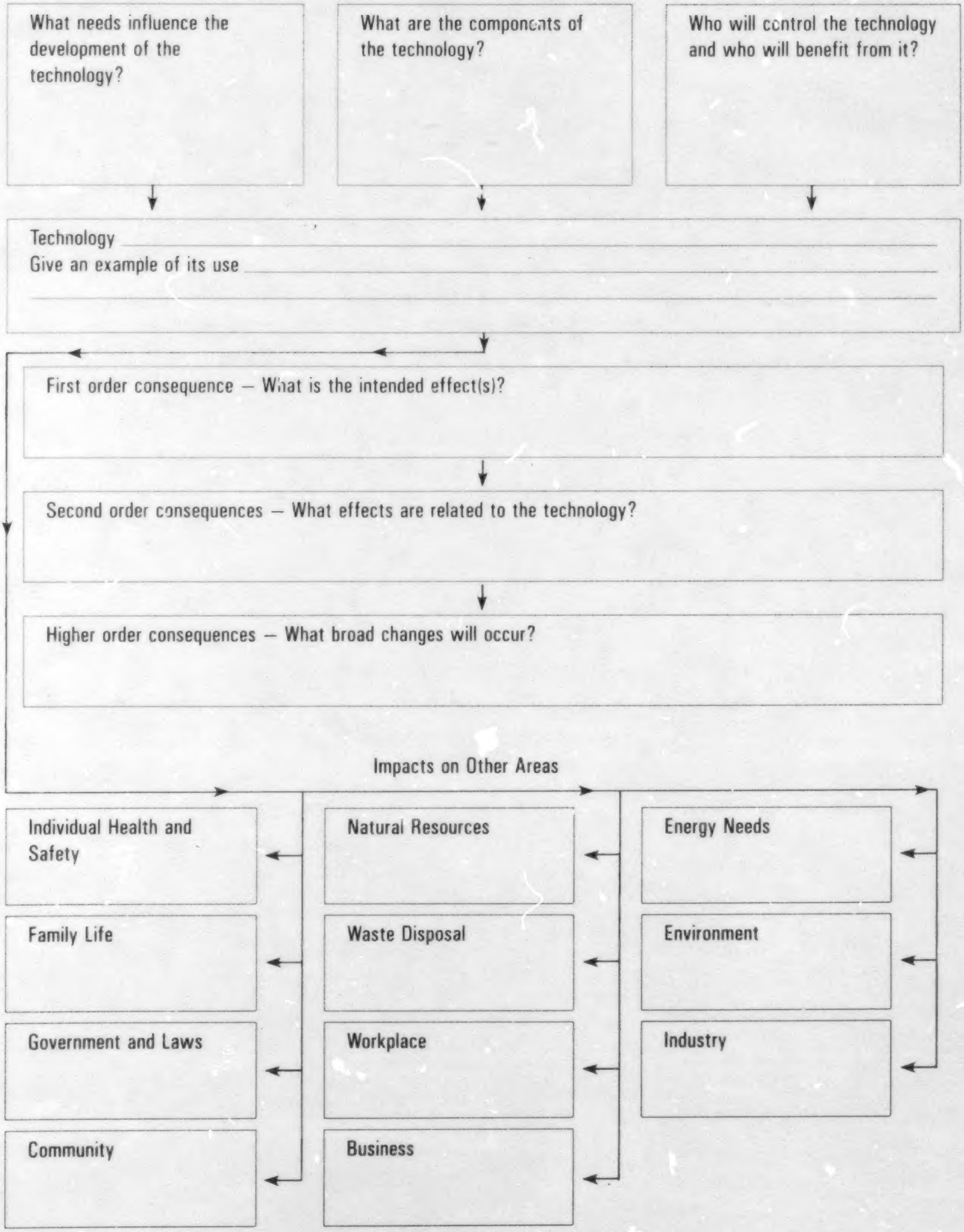
Court evaluates each technology and approves or rejects

Part III

Individually or in small groups, student writes a scenario of the future which describes how the accepted technologies have been applied

STUDENT HANDOUT THREE

TECHNOLOGY ASSESSMENT WORKSHEET



What needs influence the development of the technology?

What are the components of the technology?

Who will control the technology and who will benefit from it?

Technology ____________________

Give an example of its use ____________________

____

First order consequence — What is the intended effect(s)?

Second order consequences — What effects are related to the technology?

Higher order consequences — What broad changes will occur?

Impacts on Other Areas

Individual Health and Safety

Family Life

Government and Laws

Community

Natural Resources

Waste Disposal

Workplace

Business

Energy Needs

Environment

Industry

Figure 1: An Example

TECHNOLOGY ASSESSMENT WORKSHEET

What needs influence the development of the technology?
- farm land decrease
- population increase

What are the components of the technology?
- advanced fishing gear
- underwater sensors
- new food processing techniques
- ocean factories, electronic traps

Who will control the technology and who will benefit from it?
- ocean farming companies
control nations

Technology Ocean farming

Give an example of its use Cultivating plankton and other small plants and animals and raising fish under controlled conditions (fish farming)

First order consequence – What is the intended effect(s)?
Increase world food production significantly

Second order consequences – What effects are related to the technology?
- reduce malnutrition - population increase
- new types of food products - eating habits change
- inland nations are at a disadvantage

Higher order consequences – What broad changes will occur?
need for greater cooperation among nations regarding use of seas - world sea court to resolve disputes - form international companies to farm oceans.

Impacts on Other Areas

Individual Health and Safety
- less starvation
- improved diets

Family Life
- father spend months out at sea
- change in dinner menus

Government and Laws
- disputes among nations over who had rights to use the oceans

Community
- people move to coastal towns to be close to jobs

Natural Resources
- habitat of existing sealife may be disrupted
- some species become extinct

Waste Disposal
- waste from the factories need to be treated properly

Workplace - more jobs for fisherman and marine biologists
- reduce unemployment
- dangers of violent storms

Business greater demand for seafood products
- enlarge fishing fleets
- boom in boat building

Energy Needs
- reduce need for petroleum to produce fertilizer

Environment
- coast becomes more crowded
natural food chain may be disrupted

Industry
floating factories at sea

TECHNICAL INNOVATIONS VERY LIKELY IN THE NEXT TWENTY YEARS[1]

1. Many applications of lasers, and masers for sensing, measuring, communications, cutting, heating, welding, power transmission, illumination, destruction (defensive), and other purposes.
2. New or improved superperformance fabrics such as plastic paper, man-made leather, synthetic silk.
3. New or improved materials for equipment and appliances (plastic, glasses, alloys, ceramics, intermetallics, and high heat resistant compounds).
4. New airborn vehicles (ground-effect machines, vertical take off and landing and short take off and landing, super-helicopters, giant and/or supersonic jets).
5. More reliable and longer-range weather and earthquake forecasting.
6. Intensive and/or extensive expansion of tropical agriculture and forestry.
7. New sources of power for ground transportation, such as storage battery, fuel cell, propulsion (or support) by electro-magnetic fields, jet engine, turbine, and the like.
8. Extensive and intensive worldwide use of high altitude cameras for mapping, prospecting, census, land use, and geological investigations.
9. New methods of water transportation, such as large submarines, flexible and special purpose "container ships," or more extensive use of large automated single-purpose bulk cargo ships.
10. Major reduction in hereditary and congenital defects through early fetal diagnosis and genetic counseling.
11. Extensive use of cyborg techniques such as mechanical aids or substitutes for human organs, senses, limbs or other components.
12. More effective appetite and weight control, such as drugs or stimulation of brain hunger centers with electrodes.
13. New techniques and types of schools for adult education.
14. Genetic engineering to produce new and useful plant and animal species.
15. Human "hibernation" for short periods (hours or days) for medical purposes.
16. Inexpensive design and acquiring of "one of a kind" items through use of computers and automated production.
17. Controlled and/or supereffective relaxation and sleep.
18. More sophisticated architectural engineering such as geodesic domes, "fancy" stressed shells, pressurized skins, and esoteric materials.
19. New or improved uses of the oceans, such as mining, extraction of minerals, controlled "farming," tidal power.
20. Three-dimensional photography, illustrations, movies, and television.
21. Use of more automatic devices in housekeeping and home maintenance.
22. Widespread use of nuclear power plants.
23. Use of nuclear explosives for excavation and mining, generation of power, creation of high-temperature-high-pressure environments, and/or as a source of neutrons or other radiation.
24. General use of automation and machine controlled tasks in management and production.

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[1] Adapted from Herman Kahn and Antony T. Wiemer, *The Year 2000*, New York: Macmillan, 1967, and Stephen Rosen, *Future Facts*, New York: Simon and Schuster, 1976.

25. Extensive and intensive storage of current and past personal and business information in high-speed centralized computer data banks.

26. Other new and possibly pervasive techniques for surveillance, monitoring, and control of individuals and organizations.

27. Some control of weather and/or climate such as rainmaking, changing courses of hurricanes, and suppressing lightning.

28. Other (permanent or temporary) changes — or experiments — with the overall environment, such as the "permanent" increase in radioactive carbon and temporary creation of other radioactivity by nuclear explosions, and the increasing generation of CO_2 in the atmosphere.

29. New and more reliable "educational" and propaganda techniques for affecting human behavior — public and private.

30. Practical use of direct electromechanical communication between the brain and a computing machine so that the brain can control machines and vice versa.

31. Human hibernation for relatively extensive periods (months to years).

32. Cheap and widely available war weapons and weapon systems.

33. New and relatively effective counterinsurgency techniques, and perhaps also insurgency techniques.

34. New techniques for very cheap, convenient, and reliable birth control.

35. New, more varied, and more reliable drugs for control of fatigue, relaxation, alertness, mood, personality, perception, fantasies, and other states of awareness.

36. Capability to choose the sex of unborn children.

37. Improved capability to "change" sex of children and/or adults.

38. Other genetic control and/or influence over the "basic makeup" of an individual.

39. New techniques and types of schools for the education of children, such as advanced teaching machines.

40. Prolonging of life, postponement of aging, and limited regeneration of organs and limbs.

41. Greater acceptance and consumption of artificial foods and beverages, such as carbohydrates, fats, proteins, enzymes, vitamins, coffee, tea, cocoa, and alcoholic beverages.

42. "High quality" medical care for undeveloped areas such as use of medical aides and technicians, specialized hospitals, more effective antibiotics, and artificial blood plasma.

43. Design and extensive use of responsive and supercontrolled environments for private and public use (for pleasurable, educational, and vocational purposes).

44. Simple techniques for extensive and "permanent" changing of features, "figures," perhaps complexion and even skin color, and even physique.

45. More extensive use of transplantation of human organs.

46. Permanent manned satellite and lunar installations-interplanetary travel.

47. Application of space life systems or similar techniques to terrestrial installations.

48. Permanent inhabited undersea installations and perhaps even colonies.

49. Automated grocery and department stores.

50. Extensive use of robots and machines "slaved" to humans.

51. Underground "tunnels" for private and public transportation and other purposes, such as a tubecraft system that permits travel at speeds of 14,000 miles per hour.

52. Automated instantaneous credit, audit and banking systems.

53. Chemical methods for improving memory and learning, such as "knowledge" pills that transfer learning.

54. Greater use of underground buildings.

55. New and improved materials and equipment for buildings and interiors, such as variable transmission glass, heating and cooling by thermoelectric effect, and electroluminescent and phosphorescent lighting.

56. Widespread deep freezing, supercooling techniques, especially for storing living tissue and organs.

57. Improved chemical control of some mental illnesses and some aspects of senility.

58. Mechanical and chemical methods for improving human thinking more or less directly.

59. Inexpensive and rapid techniques for making tunnels and underground cavities in earth and/or rock, using high speed electrons from particle accelerator.

60. Major improvements in earth moving and construction equipment.

61. New techniques for keeping physically fit and/or acquiring physical skills.

62. Commercial extraction of oil from shale.

63. Recoverable booster rockets for economic space launching.

64. Individual flying platforms.

65. Inexpensive high-capacity, worldwide, regional and local (home and business) communication using satellites, lasers and thin glass fibers.

66. Practical home and business use of "wired" video communication for both telephone and TV, including retrieval of taped material from libraries or other sources and rapid transmission and reception of copies, including news, library material, commercial announcements, instantaneous mail delivery, other printouts, and so on.

67. Practical large-scale conversion of seawater to fresh water.

68. Pervasive business use of computers for the storage, processing, and retrieval of information.

69. Shared time (public and interconnected?) computers generally available to home and business on a metered basis.

70. Other widespread use of computers for research and professional work such as translation, teaching, literature search, medical diagnosis, traffic control, crime detection, computation, design, analysis and to some degree, as intellectual collaborator generally.

71. General availability of inexpensive transuranium and other esoteric elements.

72. Space defense systems.

73. Inexpensive and reasonably effective ground-base ballistic missile devices.

74. Very low-cost buildings for home and business using pre-built modular systems.

75. Personal "pagers" (perhaps even two-way pocket phones) and other personal electronic equipment for communication, computing, and data processing program.

76. Direct broadcasts from space satellites to home receivers.

77. Inexpensive (less than $20), long lasting, very small battery operated TV receivers, and miniature TV cameras the size of a deck of cards.

78. Home computers to "run" household and communicate with outside world.

79. Maintenance-free, longlife electronic and other equipment.

80. Home education via video and computerized and programmed learning.

81. Stimulated and planned and perhaps programmed dreams.

82. Inexpensive (less than one cent a page), rapid high-quality black and white reproduction; followed by color and high-detailed photography reproduction — perhaps for home as well as office use.

83. Two-way video television.

84. Flexible penology without necessarily using prisons, such as the use of modern methods of surveillance, monitoring, and control of violent behavior with drugs.

85. Common use of (longlived?) individual power source for lights, appliances, and machines.

86. Inexpensive worldwide transportation of humans and cargo.

87. New methods for rapid language teaching.

88. Extensive genetic engineering of plants and animals.

89. New biological and chemical methods to identify, trace, incapacitate, or annoy people for police and military uses.

90. New and possibly very simple methods for lethal biological and chemical warfare.

91. Artificial moons and other methods for lighting large areas at night.

92. Extensive use of "biological processes," such as microorganisms, in the extraction and processing of minerals and energy production.

93. New methods of producing electricity such as from magnetohydrodynamic generators which blow hot gas through a magentic field.

94. Scanning brain waves or eye movements to more accurately measure human intelligence, behavior or attitudes.

95. Extreme high strength and/or high temperature structural materials, such as plastics that resist heat and scratching.

96. Shopping by a push button telephone and communicating directly with the computer.

97. Computers that talk as well as understand and respond to human speech.

98. Production of food proteins from wastes.

99. Automated conveyor belts or robots to deliver messages and packages in large offices.

100. Entire books printed on a single card-size sheet of microfilm.

101. Use of algae to generate hydrogen fuel from water and sunlight.

102. "Space mitts" to salvage objects and debris from space.

103. Solar power beamed by microwaves to earth by satellite stations.

104. Use of microwaves to weed fields.

105. Widespread use of moving sidewalks for local transportation.

106. Offshore floating platforms to house nuclear power plants, airports, apartment houses, etc.

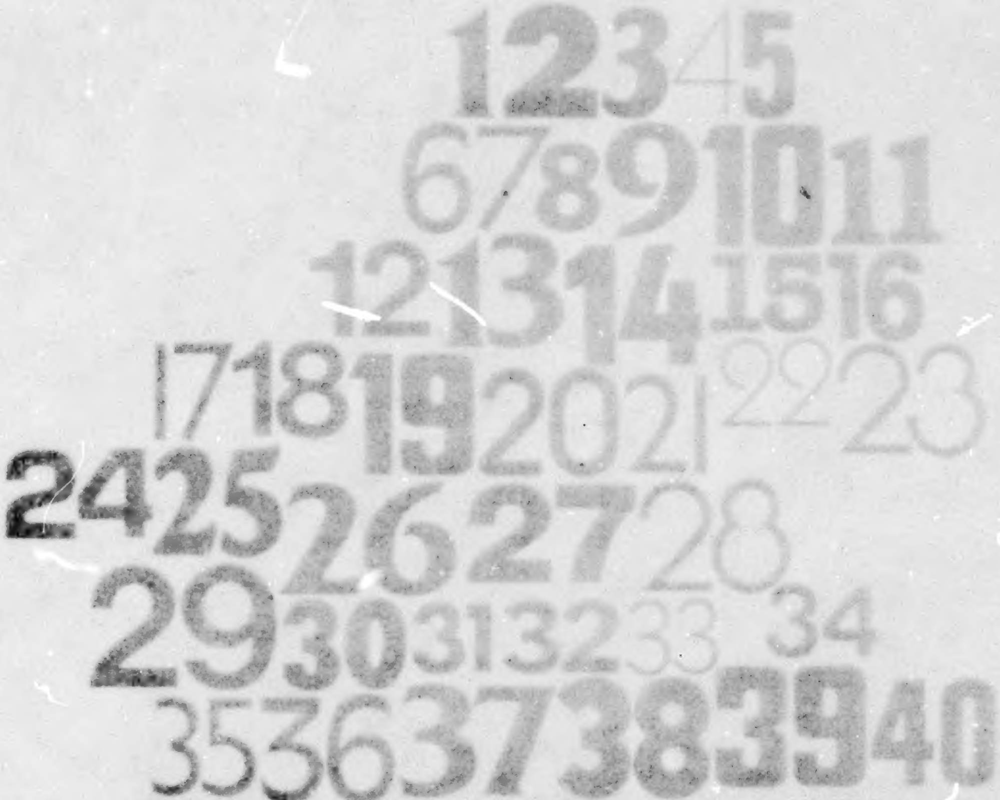
107. Explosives with greater power and more precision for demolishing structures.

108. Use of radiation to sterilize and preserve foods.

109. Use of algae to purify wastewater and produce paper.

110. Use of gels and microorganisms to clean up oil spills.

Reading 15



Forty-one Future Problems

Here is the list of long-term societal problems identified by researchers at SRI International's Center for the Study of Social Policy. The emphasis is on national or international-scale problems that could become major societal crises in the coming decades but are not very widely recognized at the present time.

1. **Malnutrition-Induced Mental Deficiencies Leading to Social Instability.** Malnutrition during the prenatal period and infancy seems to result in permanent mental and emotional damage. The social and political results of mentally deficient and possibly emotionally unstable populations, especially in the third world where malnutrition is endemic, will be serious for an increasingly complex and interdependent world.

2. **The Cultural Exclusion of the Aged.** In all developed countries the absolute and proportional growth of the aging population is straining social and economic institutions. Growth occurs through a combination of demographics, lengthening life span, and earlier retirement. The economic problem is that of an increasing economic load per worker to support the aging, which may intensify the political conflict between young and old. The sociocultural problem is that of wasted lives—citizens without participating roles. The breakdown of extended family structures in many nations is making the time of growing old one of enforced idleness and loss of meaning in life. Structural change in society may be required for the eventual resolution of the problem of aging.

3. **Global Firewood Shortage.** About one-third of the world's population relies on wood as its principal fuel. Rising population has created overwhelming demands on forest reserves, particularly in Africa, the Indian subcontinent, and Latin America. The major consequence has been massive deforestation, with resultant flooding, erosion, climate change, and loss of land suitable for farming. The substitution of animal dung for wood fuel has further damaged the soil by denying it natural humus and fertilizer. High prices for fossil fuels dis-

courage wood-dependent peoples from abandoning destructive use of wood and animal wastes.

4. **Critical Advances in Biomedical Technology.**

- *Access to Life Extension.* The development of life-extending medical techniques raises important questions about access. Experience with renal dialysis machines indicates that the supply of surgeons and of natural organ or machine replacements will probably not meet demand.
- *Genetic Engineering.* Developments in bioscience, particularly in what is called genetic engineering, pose unprecedented social and ethical problems. The ability to control the sex of human beings and their physical, mental, and emotional characteristics (using techniques modeled on animal husbandry) threatens the moral basis of human social organization. These forms of population shaping and control are more direct than even drug or mass psychological manipulation.
- *Euthanasia.* Strong movements are developing for the adoption of euthanasia to dispose of the aged and unfit. Supporters of this movement promote the concept of voluntary death for those lacking a place in society.

5. **The Growing Conflict Between Central Control and Individual Freedom.** The advance of science has produced technologies of enormous power, scale, and sophistication. The size and scope of both public and private organizations have grown enormously in the past 200 years. Many of society's ills, especially crime, the economy, and energy, seem to be demanding immediate and effective solution. The growth of giant urban complexes, with highly mobile populations, contributes to the decline of social cohesion and binding institutions, such as the community and the family.

The power of our technology seems to require equally powerful regulation. The scale of our organizations increasingly makes them remote from and dominant over the citizenry. The urgency of problems often seems to demand the sacrifice (albeit willing) of individual freedoms and sometimes of civil liberties (the threat of airplane hijacking led to warrantless search at airports). The decline of social cohesion places ever greater demands on the formal institutions of society. The net result is a reduction in the accountability of institutions, in the efficacy of individual choice, and in the preservation of civil liberties—in short, producing the conditions for a progressively authoritarian society.

6. **The Conflict Between Low Growth and Rising Expectations.** Worldwide expansion of communications and transportation networks is leading to rising material expectations and a growing sense of inequity among those in the lower economic spectrum. The gap between rich and poor nations grew rapidly from only $100-$200 (per capita product) in 1850 to over $2000 in 1970. Until recently, world industrial growth was seen as the chief means of closing the gap. However, if the world is, indeed, facing fundamental limits to growth or, for other reasons, nations are unable to achieve growth, expectations will be frustrated. Widening the gap will increase the likelihood of political instability and violence.

7. **Police Alienation From the Populace.** New technology is having an unanticipated effect on the nature of U.S. law enforcement activities. The demand has been for technological augmentation and extension of each officer's capabilities. The economic pressures that necessitate increasing the area of his coverage, the speed of his response, and the level of force he employs have increased the social distance between the officer and the citizens he serves. Alienation of police officers from all segments of our society is such that police forces are regarded in some places as an army of occupation.

8. **Loss of Cultural Diversity.** The emergence of one interdependent world economy linked by rapid communications and transportation is leading to homogenization of world culture. The resulting standardization would allow greater economic efficiency and greater political and social stability. However, a culturally unified world might be less adaptable and less creative than a culturally heterogeneous one. It is well known that a complex ecology (e.g., a tropical rainforest) has greater potential for survival and is more stable than a simple ecology (e.g., monoculture). Moreover, our rich mix of cultural systems is worth preserving because such systems have intrinsic worth and may also contribute understandings essential to the solution of human problems.

9. **Potential for New Urban Violence.** The deterioration of older American cities and the decline of their economies threaten to trap urban populations in a situation not unlike that of Appalachia. The situation of these depressed and despairing agglomerations—including already impoverished minority groups—portends widespread and persistent violence. Quasi-guerilla warfare in the inner cities with raids against outlying, more affluent areas and assaults against police and public service facilities may reach intolerable levels.

10. **The "Invisible" Famine.** Even slight variations in world climate can have significant impacts on food and hunger problems. Because this effect is widespread, an "invisible famine" blankets many of the poor nations rather than being focused in a particular geographic area. The victims are likely to be in less visible rural areas because city populations are fed first to ease the threat of disruption there.

11. **Persistent Malnutrition Despite Affluence.** Serious lack of nutrition as a result of the composition of the diet imperils even affluent Americans. New deficiencies are continually being discovered as nutritional knowledge improves. Well-known problems such as obesity, sugar overconsumption, and nutrient removal in cereal processing persist due to public taste and the influence of technology and advertising (e.g., cost and efficiency pressures in over-the-counter and other food services, and total exposure to advertising influences through TV and other sophisticated motivational methods).

12. **Teenage Alcoholism.** Heavy consumption of alcohol among adolescents (13-18 years of age) is now at about 25%. This extension of adult drinking patterns into youth groups indicates that the present serious problem of high alcohol consumption endemic in the United States may grow worse. Further, teenage alcoholism contributes to the problem of juvenile crime.

13. **Lack of Functional Life Skills in Adults.** Recent U.S. Office of Education tests indicate that less than half the nation's adults possess the basic skills to function well in today's society. More than 20% are barely able to read want ads or to do the arithmetic necessary to use a checkbook. These results raise severe questions about the efficacy of American education and suggest that as our society becomes increasingly complex many more people will be unable to master the skills necessary to function well.

14. **A Growing Subculture of the Information-Poor.** A post-industrial society places high value on possessing and effectively using information. However, the gap is widening between those who are information-rich and those who are information-poor. Economic, educational, social, and motivational factors

create an uneven distribution of ability to make use of our sophisticated new communications technology. More equal access to such technology is an ineffective solution because ability to use the technology depends on the information already held by the user. Thus, those who possess the information can use the new technology to increase their existing advantage over those who have not.

15. **Barriers to Large-Scale Technological Innovations.** All industrial nations find it increasingly difficult to carry out large-scale technological projects in critical fields such as transportation, energy, food production, environmental protection, and housing. Huge public, private, or mixed investment schemes either fail to achieve the promised results technically (e.g., the Bay Area Rapid Transit or BART) or prove far more costly than originally estimated (the Concorde SST project). Such failures—contrasted with earlier successes (railroads, airlines, television)—contribute to growing disbelief in promised benefits and discourage both private and public willingness to invest. There is a consequent loss of faith in technology and a growing reluctance to take bold innovative risks.

16. **The Social Impact of Changing Role of Women.** Increasingly, women are entering the work force. Equal opportunity laws and changing mores suggest that many will eventually assume senior positions in government and business. Moreover, they will do so without having to adapt to male behavioral norms. As the number of women in these positions increases dramatically, the nature of the institutions will probably change in response. In the long term, the change should prove productive and beneficial. During the transition, however, internal problems, resembling those of a clash of cultures, can be anticipated. Institutional effectiveness may suffer a short-term decline while the problems are resolved.

17. **The Sociocultural Impact of Media.** Rather than direct experiences in the real world, an increasing proportion of people's life experiences are vicarious through the media. Consequently, their perception of social reality may be distorted, and their judgment may be more susceptible to intentional and unintentional manipulation. They may also tend to withdraw from direct political and social participation.

18. **The Social Implications of Changing Family Forms.** During the past decade the U.S. has seen a drastic increase in the divorce rate and in the number of single-parent families. Traditionally, we have expected the products of broken homes to exhibit undesirable social behavior. If true, society can expect increased delinquency, alienation, and mental illness. Perhaps as significant is a growing acceptance of the nonpermanent marriage and nonrelated family groups, which undercut older expectations of permanence and family stability. This will have impact on the whole range of social, economic, and legal institutions designed for the nuclear family (parents and children).

19. **The Effects of Stress on Individuals and Society.** The negative effects of stress may cost the United States more than $100 billion annually. Although much is being done to treat the symptoms of stress through such remedies as drugs, there are significant aspects of the problem that are barely recognized, let alone studied. There are, for example, different types of stress—some of them potentially beneficial. Our treatment approaches tend to be monolithic, perhaps worsening some kinds of stress. Similarly we know little about societal stress resulting from individual stresses. Because stress-producing situations such as job and family insecurities seem on the rise, stress-related pathologies will also likely increase. At the same time, with growing demand for some form of national health care, the costs of medical treatment of stress-related symptoms could be expected to increase substantially. If the apparent correlation between the rate of social change and social stress is real, it can be expected that stress on the social level will rise as well.

20. **The Potential Use and Misuse of "Consciousness Technologies."** Various "consciousness technologies" constitute an applied science that draws upon medicine, physics, psychology, neurophysiology, and parapsychology. Research is revealing the potential impacts of these technologies upon humankind—both for good and for ill. Whether they present a considerable opportunity or a considerable problem depends on their diffusion and application, as illustrated below:

- *Alternative medicine*: A growing body of research indicates that many diseases involve psychosomatic mind-body interaction. If so, integrating the psychological/mind-body component into the treatment would be a potent aid in reducing disease. Serious questions about the fiscal dependability of national health care insurance and the rapid inflation of medical costs indicate that we badly need supplements to expensive traditional medicine.

- *Capacity-enhancing technologies*: Evidence exists that the human potential for rapid learning, creativity, healing, and the like exceeds customary assumptions. Consciousness research suggests sociocultural barriers and professional taboos may be restricting application of new techniques in problem solving, health care, education, and criminal rehabilitation.

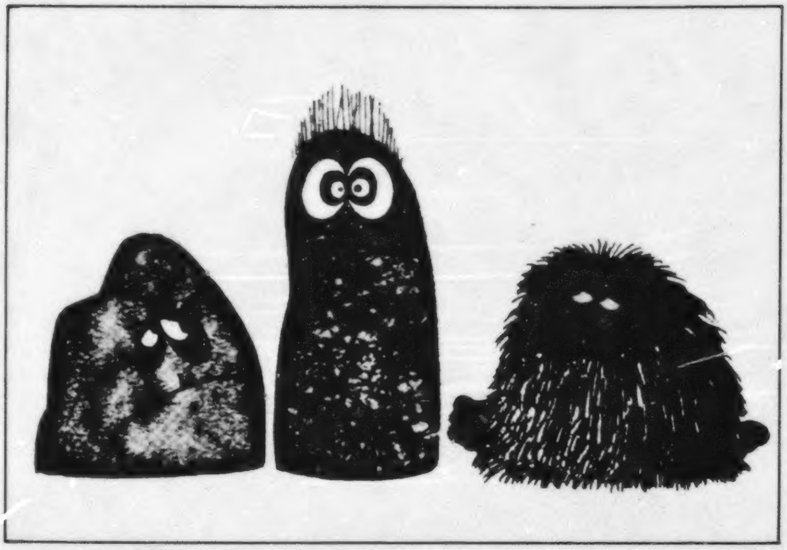
- *Psychic abilities.* There is growing evidence that psychic abilities may exist and that they may have considerable potential for misuse, principally in two forms: acquisition of confidential information and generation of long-distance effects that could by psychologically disorienting and physically harmful. At present we have insufficient information to evaluate with confidence whether such abilities exist or the threat presented by this technology of mind—a technology that may be rapidly developed, given current scientific investigations.

21. **Decreasing Capital Productivity of New Technology.** New technology seems to offer increasingly small return on capital investments. Investors fear that prevailing commodity prices in many industries are too low to support the risk and that necessary increases would not be supported in the market. The alternative is to seek government subsidy or tax incentives. However, to do this is to invite government regulation or intervention in business decision-making. Rather than risking an uncertain market or sharing control with the government, industrialists may increasingly elect to restrict their investments and live on past earnings while the general economy stagnates.

22. **Regulatory Restraints and Economic Growth.** Demand for stricter regulation of the economy appears to be rising as a result of more universal appreciation of needs (to contain pollution, conserve resources, reduce hazards), better organization of special interest groups, higher levels of public support, and distrust of large institutions. Regulation could be restrictive enough to reduce productivity, discourage free enterprise, eliminate development of significant resources, such as oil shale, and increase costs in domains such as coal mining. There may be a problem of increasingly onerous trade-offs between the need for regulation and the requirements of a healthy economy.

23. **Weapons Technology and the Right to Bear Arms.** In the past, certain weapons (explosives and machine guns) have been excluded by law from inclusion in the constitutional right to bear arms. However, new weapons technology, resulting from military research and the public's demand for better anticriminal weapons, is already beginning to strain existing laws. Weapons such as electric-shock Tasers and tranquilizer guns are already widely available. Controlling this proliferation of new weapons is difficult because of a perceived growing gap between the arms allowed the private citizen and the arms used by the police and military.

24. **Cumulative Effects of Pollution.** As new industrial processes are developed and new products are manufactured, the number and quantity of new chemical compounds released into the environment have increased dramatically. The effects of these compounds on human health and personality and on the stability of the ecosystem may be unknowable for years or even generations. The large number of such new compounds (estimated at about 5000 per year) makes it almost impossible to establish an acceptable testing program, which is the necessary first step in determining potential deleterious effects. Monitoring of pollutants, understanding how they reach man and his environment, characterizing their interactions with other chemicals, and assessing their potential for inducing low-level, long-term effects are beyond our present capabilities.



Problem 14: A Growing Subculture of the Information-Poor. To combat widespread ignorance concerning venereal disease, the Walt Disney Educational Media Company prepared a film-strip featuring these unsavory characters—shame, fear, and ignorance. Despite the increasingly vast quantities of information in the world, many people lack the basic knowledge they need to function effectively.

Drawing copyrighted by Walt Disney Productions

25. **Limits to the Management of Large, Complex Systems.** The power to create large complex systems (economic, political, social) does not automatically confer the power to effectively control such systems. There is growing evidence that we have aggregated small, comprehensible systems into supersystems that are very difficult to manage at all, let alone in a democratic, participatory fashion. Further, large, complex systems tend toward conditions of relatively low performance as they become more incomprehensible and less amenable to democratic control. There is a trade-off between reduced efficiency and increased capacity for survival through many levels of backup systems. Large, complex systems also tend to become increasingly vulnerable to disruption at key points as a consequence of increasing levels of interdependence. They also demand an ever higher level of self-discipline on the part of individuals.

26. **The Apparent Conflict Between World Peace and World Justice.** The success of efforts to preserve world peace and a tendency to replace peace with stability and the absence of conflict may result in the preservation of existing inequities within and between nations. This poses the danger of the defense of injustice in the name of peace and the danger of far more serious and uncontrollable eruptions in the futrure.

27. **Catastrophic Experiments.** The destructive potential of some new and emerging technologies has raised questions about whether some experimentation might have catastrophic results and, hence, should not be permitted. However, the traditional ethic and practice of science and the potential benefit foreseen from the successful development of such technologies seem to demand that the experimentation go forward in spite of the risk. Examples can be drawn from physics (especially the nuclear field) and from the biological sciences (e.g., test tube creations of new strains of bacteria). No mechanism exists for identifying potentially catastrophic experiments.

28. **Vulnerability of Water Supplies.** The development of highly toxic chemicals and bacteriological substances and the increasing availability of powerful radiological materials pose a clear and present danger. Their accidental or deliberate introduction into public water supply systems would have disastrous results. The complexity of modern water supply systems and the vast populations they serve exacerbate the problem.

29. **The Dangers of Computer Dependency.** Increasing reliance on computers and a lag in supporting functions that make computer technology safe are becoming a national and an international problem. Legislative attention is being given to the loss of personal privacy relative to computer data banks. However, even more serious losses are increasingly associated with the use of computers and data telecommunications. Innovations such as electronic funds transfer (EFT), point transaction automation, and process control (such as rapid transit scheduling) entailing the safety of human life are accelerating the number and seriousness of risks due to accidental or intentional disruptions or loss of information.

30. **Decreasing Utility of Higher Education.** The formal educational system may be increasingly inefficient in training people to perform needed tasks, especially those of coping with a technologically advanced society. The universalization of access to colleges and universities may be diluting the quality of curricula designed for individual personal development. Thus, higher education may be contributing less to individual and social needs and may no longer ensure the greater personal and societal rewards traditionally expected.

31. **Effects of Technology on the Individual Psyche.** Constant exposure to technological devices may be having a serious impact on the human psyche. Examples are numerous: media-presented violence with its concomitant effect on the human approach to life; high mobility which leads to rootlessness and weakening of family ties; excessive television viewing, which blurs the distinction between reality and fantasy; an overload of stimuli, which leads to ever higher needs for sensation. Few systematic attempts have been made, however, to observe or measure such changes or to determine their effects.

32. **Loss of Political and Social Cohesion.** There seems to be a decline in political and social cohesion—the sense of shared purpose that provides the balance between individual desires and the general well-being. This decline seems to result from a number of forces, including high mobility; erosion of communities; the replacement of the extended family with the nuclear family; an inward turning to personal goals resulting from a sense of individual powerlessness in a mass society; and the growth in effectiveness of interest group politics. The consequence of this loss is the undermining of the efficacy and legitimacy of society's basic institutions.

33. **Institutional Boundaries as Impediments to Societal Problem-Solving.** As the scope, scale, and concentration of human activities have increased, our societal institutions have become more tightly interconnected. Institutional boundaries created for a less tightly coupled society tend to compartmentalize aspects of problems and to resist more comprehensive attempts at solutions. The resulting frustration and conflicts call into question the legitimacy of the entire institutional fabric of the society and generate demands and violent actions aimed at its destruction.

34. **The Need for Better Socioeconomic Models.** At a time when the managers of both corporate business and government have developed powerful tools for systems management, it is important that their models be accurate for the systems they propose to manage.

Unfortunately, management technology appears to have grown faster than design capabilities for social science systems. There is a danger that management tools will be ineffective because the social systems model is insufficient for assessing the problem and defining the remedy.

35. **Advanced Microcomputers and Rights to Privacy.** The development of powerful microcomputers, combined with improved semiconductor memories, will make possible inexpensive and highly sophisticated individual surveillance and the maintenance of vast numbers of data banks. Individuals will find it impossible to know who is keeping dossiers on them and what information is in those dossiers. Privacy and other personal rights will be threatened as this technology develops.

36. **Chronic Unemployment.** Contrary to many predictions, fundamental changes in the economic situation (e.g., environmental and other constraints to economic growth, and basic long-term capital shortage) present the possibility of chronic unemployment. Various analyses indicate high degrees of hidden unemployment at present, and more in the future. Various societal full-employment bills in Congress betray awareness of the problem. Inaccurate identification of the long-term nature of the new unemployment could result in expensive attempts to resolve the problem with the wrong approaches.

37. **Social Response to Energy Disappointments.** Delays and uncertainties will almost certainly occur in obtaining new energy sources over the next decade. In the interim, economic uncertainties will make private investors reluctant to invest heavily in older technologies. Inevitably, strong pressures will be exerted for control of consumption through rationing and for nationalization of utilities and of the coal, oil, and gas industries. These delays and associated conflicts could result in a number of negative social consequences.

38. **A Growing Need for "Appropriate Technology."** There is a growing array of "appropriate" or "intermediate" technology that could provide practical support for a much-simplified way of living. Examples of these technologies include solar power, wind power, intensive gardening, biological means of pest control and fertilization, and composting toilets. In general, these technologies tend to be ecologically more sound, energy conserving, comprehensible, and efficient when used on a small scale.

As we confront apparent limits to growth—whether induced by economic or political forces—we may have to simplify our level and patterns of consumption. Failure to nurture, in appropriate ways, the development of intermediate technology and supportive social forms will make it more difficult to solve the practical and pressing problem of finding new ways to live healthily in a world of increasing scarcity. Failure to develop appropriate technology would also result in a missed opportunity for creative social and technical learning during a time of stress and transition.

39. **The Societal Changes Required to Adapt to New Energy Sources.** Even though new sources of energy from advanced technologies may produce abundant cheap energy, the form in which the energy is available could be quite different from fossil fuels. Thus, when diminishing fossil fuel supplies have become prohibitively costly, we may find ourselves with a system whose structure and behavior are inappropriate for the new forms of energy. If required changes could be anticipated, we might more effectively plan long-term investments and prevent undesirable consequences.

40. **Emerging Nations and the End of Oil.** Over the next 25 years as the developed nations invent and install new energy sources, they will deplete most of the world's oil reserves. As they do so, they will deprive much of the third world of access to cheap fuel at a time crucial to development. Because the new alternative energy sources may be too complex and costly for these poorer nations, they may be relegated to permanent poverty.

41. **Social Effects of Redefining Legal Liability.** Increasing complexity, interdependence, and scale of action in society have increased the potential liability for decisions of individuals and organizations, while permitting lines of responsibility to blur. Legal devices to avoid responsibility tend to reduce the legitimacy of existing institutions and to reinforce loss of trust and confidence in institutions and the professions. Loss of trust and confidence, in turn, has been reflected in increasing resort to the courts to seek redress for real or imagined grievances. Consequently, entrepreneurial and professional risk-taking has become far more hazardous.

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Reading 16

An Agenda for the 1980s

by Edward Cornish

Here are three different forecasts for the 1980s. One forecast assumes that current trends will continue; a second anticipates that many things will go wrong; and a third, an optimistic scenario, assumes that the world will luck out on many counts. Time will tell which of these forecasts comes closest to the reality as it will develop during the decade. What we can be more sure of is that we face a variety of critical choices and the decisions that we make about these issues will have a major influence on the events.

As the 1970s came to an end, newspapers and magazines published numerous articles predicting developments during the new decade. Most of the articles were based on the assumption that the trends of the 1970s will continue through the 1980s: Population will continue to grow, the economy will pursue its current lackluster path, and computer technology will proliferate at an ever-increasing rate. But the 1980s may turn out to be a decade when many important trends change direction. If so, forecasts made by simply projecting current trends into the future may result in more than the usual number of embarrassing failures to anticipate correctly the shape of things to come.

The world seems to have entered a phase in which some key trends have lost their force and the structure of many institutional arrangements has been seriously undermined. For instance, economic growth, which was so strong during the 1950s and 1960s, has greatly slowed in many countries, and some now find their economies stagnant or even declining. The relative decline in the power of the United States—the nation that once provided protection for non-communist countries around the world—has led to new uncertainties about the stability of the international order. Additional sources of major change may be found in the massive transfer of wealth from the industrialized nations to the oil-producers; the decline of the dollar; the growing chaos in financial markets; the increasing stridency of the developing nations' demands on the developed countries; and the seemingly irresistible spread of nuclear weapons. The resulting tensions could lead to serious confrontations and breakdowns that would greatly alter the world that might be anticipated simply by extending current trends a few years into the future.

Extending current trends into the future is not a bad way to begin thinking about the future, but it is unwise to stop there. Yet most of the recent articles about the 1980s give little consideration to any forecast except the one they regard as most probable, which, of course, is the one created by simply extending the trends. This practice of excluding alternative possibilities is risky because it suggests that we need give no thought to any possibility except the one chosen as most likely. If something else happens—something deemed to have a lesser chance of realization and therefore not worth considering—we will be totally unprepared. The "single-forecast" practice presumably led the French

Above: Halley's comet will reappear in the sky in 1985 after an absence of 76 years.

Photo: Yerkes Observatory

army in the 1930s to develop the Maginot Line—a series of fortifications admirably suited to the trench warfare of the 1914-18 period but laughably inadequate against the assault of Nazi Germany in 1940.

The articles about the 1980s also seem to assume that the best people to make forecasts are specialists, especially if they are also government officials. For instance, the person best qualified to forecast the future of the automobile might be an automobile specialist in the Department of Transportation. Yet experience has shown over and over again that developments in any given field may be revolutionized by events occurring outside that field, and presumably beyond the purview of the specialist. Artificial fibers such as nylon and dacron drastically altered the clothing business, but the fibers were developed by the chemical industry, not the clothing industry. During the 1970s, the greatest development in the typesetting industry was perhaps the application of computer technology to typesetting: this resulted in a massive displacement of earlier methods of typesetting and the redundancy of thousands of typesetters in newspapers.

Another characteristic of the forecasts that have appeared recently is their generally optimistic tone. Perhaps nowhere is this more evident than in *The Exciting '80s* by Arnold Barach (Kiplinger Washington Editors, Washington, D.C., 1979). Although Barach is careful to insert occasional caveats and disclaimers, the general mood of the book is strongly upbeat: Readers can look forward to a generally rosy future, thanks to new technological developments and continued economic growth.

The Emergence of Futurism

The 1960s saw the emergence of the future as a subject for serious study in its own right. It was a decade highlighted by the pioneering work of Olaf Helmer and his colleagues at the Rand Corporation; Bertrand de Jouvenel's Futuribles project in Paris; and the founding of the Hudson Institute and the World Future Society. What, if anything, can the emerging study of the future contribute to people's understanding of the new decade? Perhaps the most important insight that futurists can offer is that the future cannot be predicted! The future is not a world that lies before us quietly awaiting our arrival but rather a world that we ourselves are creating. The future, then, is not fixed. Many different "futures" may develop out of the present moment in which we live. For that reason, we should explore a number of possible future worlds, not just a single "most likely" possibility. Again and again, experience has shown that something viewed as wildly improbable or even impossible turns out to be what actually occurs. We may lack the time to study carefully all the possibilities, but experience suggests that we ought to at least look at more than one. Even if no one possibility turns out to be precisely on target, the experience of considering several alternatives keeps our minds open and ready for whatever contingencies may actually occur.

Alaska pipeline section gets a serial number. The world's hunger for petroleum and other forms of energy is expected to play a crucial role in developments during the 1980s. Photo: Alyeska Pipeline Service Company

Photo: NCR

Computer and other electronic technology is expected to proliferate during the 1980s.

The "alternative futures" approach opens the gateway to a future that we choose and shape rather than one that is simply thrust upon us when we have reached the appropriate moment in time. To develop a series of alternative futures, we can start by developing a "standard" or "surprise-free" forecast, based on the assumption that present trends will continue, but after that we should develop others. One possibility is an "optimistic" scenario postulating that things will be much better than we currently expect; another possibility is a "pessimistic scenario" that assumes many of the bad developments that we think are possible will in fact occur. Many more scenarios could be developed but these three (standard, optimistic, and pessimistic) give us a basis for the all-important psychological leap into the future.

Here are three highly abbreviated scenarios for the 1980s:

Standard scenario: Many things will happen during the 1980s, but essentially the decade will see a continuation of the trends of the 1970s. World population will grow; but living standards will remain about the same. Terrorism may increase, and there may even be a few small wars, but probably no World War III. Many advances will occur in technology, especially electronics and communications, but the economic benefit of these advances will be largely offset by the shrinkage in

"Perhaps the most important insight that futurists can offer is that the future cannot be predicted!"

Haitian children receive food under a program supported by the U.S. Agency for International Development. During the 1980s, declining economic conditions could make it difficult for wealthy nations to continue to provide food for swelling populations in the poor countries.

the amount of prime natural resources—petroleum, metal ores, forests, farm land, etc.

Pessimistic scenario: The world economy will deteriorate badly in the 1980s due to high population growth, the exhausting of natural resources, failure of nations to curb inflation and soaring debt, and other factors. The developed countries will face soaring unemployment; the developing countries will experience mass famines. Economic difficulties will lead to political unrest, with revolutions likely not only in the poor countries but also in the rich. As political chaos mounts, many democratic regimes will collapse, and, amid the chaos, new dictators will rise. Major wars—both civil and international—will occur, and there is the possibility of World War III.

Optimistic scenario: New communications devices will spearhead a parade of new technological devices that will solve most of the pressing problems of the 1970s. Microprocessors will vastly increase the efficiency with which energy is used, enabling people to keep their homes warm and drive their automobiles with far less expenditure of fuel than is now required. Breakthroughs in energy production will substantially free the world from its enslavement to petroleum and natural gas. New birth control methods will curb population growth in the developing countries, thus preventing starvation and making it possible for them to advance economically. Artificial intelligence will provide an exciting new alternative for decision-making, and increasingly, electronic devices will be entrusted with arbitrating differences among nations. At the same time, human wishes will be expressed on a mass basis through computer-communications devices hooked up to homes everywhere. As the nations move toward an anticipatory democracy mode, with huge electronic "town meetings" involving millions of people, the world will move rapidly toward peace and prosperity.

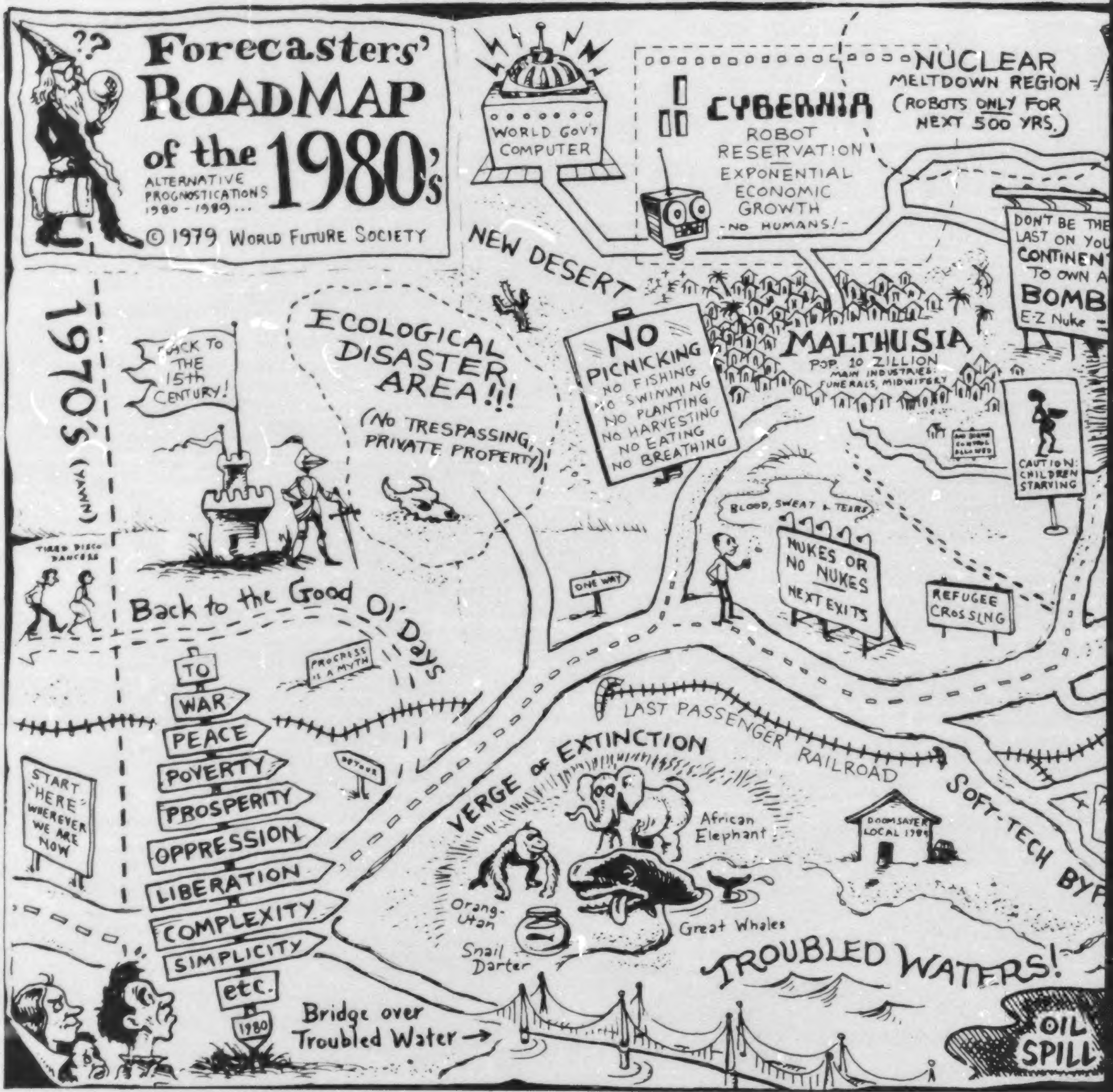
Each of the foregoing scenarios may be viewed as possible! We cannot say that it simply could *never* possibly happen, although we may view one or more scenarios as highly improbable. Probably none of the scenarios offers an accurate description of the 1980s but they anticipate at least some features of the decade.

By considering three alternative views, we are forced to see the future as a domain of possibilities rather than a realm of fixed realities that we can do nothing to change. The alternative scenarios require us to think a little about many more possibilities than we would have considered if we had viewed the future in terms of a single forecast. We now see the future not as a world that is forced upon us, but as a world that we ourselves create.

Critical Choices

Besides developing a number of scenarios for the 1980s, we can explore the new decade by identifying some of the significant issues about which people will have to make choices. These issues are often called "problems," but they are not problems in the scientific sense. A scientific problem is a matter of factual knowledge, and scientists can gradually work toward an answer that will satisfy most scientists as being correct. But the policy choices that will exercise us during the years ahead do not have "correct" answers; instead, they are challenges to us to make choices about what sort of future we want to create.

The 1980s—more than any previous decade—will be a period in which human choice will operate more decisively than ever before. The rapid development of technology has freed man from slavery to environmental and biological circumstances. No longer is he a prisoner of a particular geographic locality, because he can travel easily to the other side of the world. He can converse with people around the globe via new electronic devices. New biomedical advances are making it possible for him to have a longer life and better health. Improved economic systems have removed—at least in many nations—the once ever-present danger of starvation.



Each of the following "critical choices" can serve as the topic for a mind-stretching debate about the future. They have no right answer that a teacher can look up in the back of a book. Instead, they represent challenges that will probably remain with the world throughout the 1980s.

Complexity and democracy. The increasing complexity of modern life makes it more and more difficult for voters to understand policy issues and make wise choices among candidates. Many voters give up and stop voting at all.

What can be done to enable people to be effective participants in elections and the formation of public policies?

The enormous scale of industrial society. The modern world has developed an economic system that depends heavily on the mass production of goods by means of a heavily specialized, centralized system. In recent years, critics have suggested that many problems—pollution, family breakdown, etc.—might be alleviated through smaller-scale production ("Appropriate Technology") and the decentralization of activities.

Should efforts be made to reduce the size of factories so that each community could produce more of the goods that it uses rather than being dependent on distant suppliers for most of its needs?

Industries endangered by foreign imports. Many workers find their jobs are threatened by goods imported from other nations and de-

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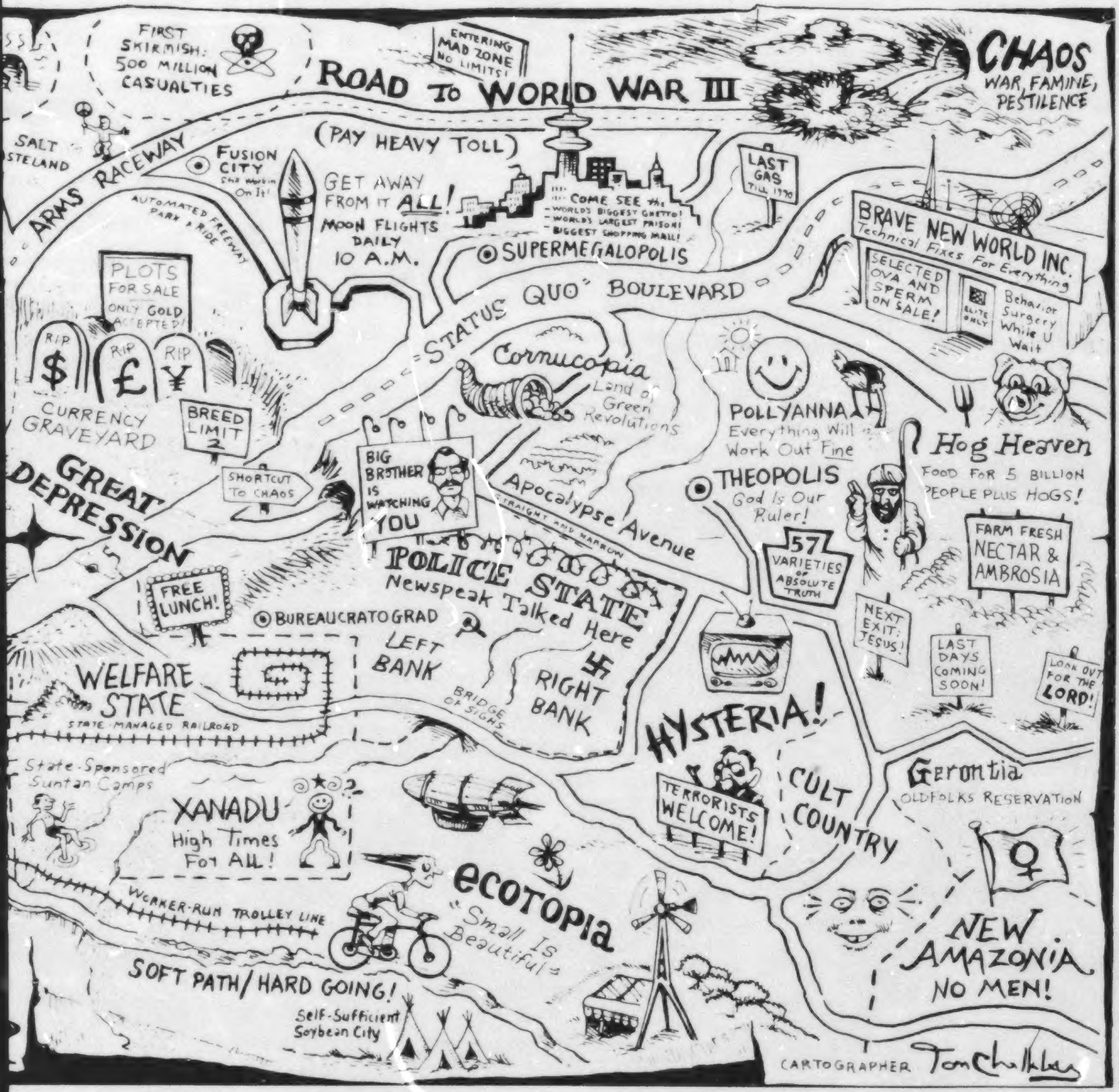

Illustration: Tom Chalkley

mand "protection"—tariffs, quotas, regulations, and other measures designed to reduce the influx of foreign goods. But such "protectionism" deprives consumers of the chance to buy better or cheaper goods from abroad and is generally deplored as hurting the overall economy. However, if domestic industries are not protected, they may go bankrupt, throwing whole regions into an economic depression. Government officials may talk about "retraining" displaced workers, but retraining may not work well because older workers cannot always acquire new skills that might command the premium wages they were receiving earlier. Nor do they wish to leave their home communities for a distant location.

What should government do when domestic industries are threatened by imports?

Minority cultures. Most nations contain groups of people with a cultural tradition different from that of the dominant culture. Canada, for example, has a large group of French speakers; France has Basques and Bretons; Britain has Welsh-speakers, etc. These groups generally want to enjoy the economic benefits obtainable through the national society but also want to preserve their own cultural heritage. But they cannot do the one without sacrificing, at least to some degree, the other. For instance, an American Indian must learn English if he wants a high-paying job, but as he learns English he tends to lose his native culture.

Should minorities be assimilated as rapidly as possible into a nation's dominant culture? Should the world aim for a single culture in the interest of economic efficiency or should

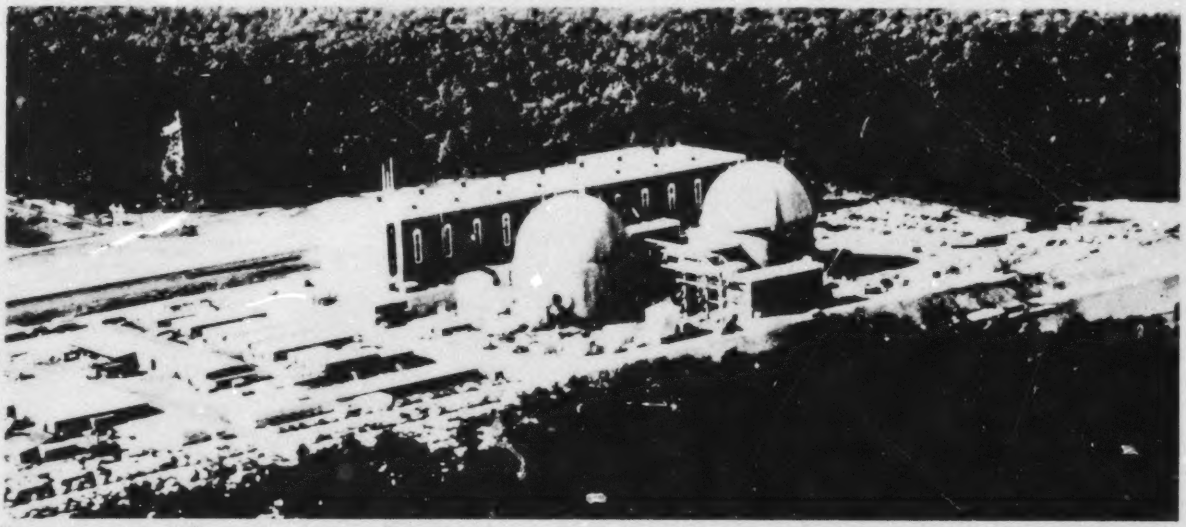

Photo Nuclear Regulatory Commission

Nuclear power plants like this installation at Surry, Virginia, now provide much of the world's electricity. Nuclear power represents an alternative to petroleum, but the risks of radioactivity and possible diversion of nuclear materials to war-making or terrorism will probably continue to make nuclear energy controversial in the 1980s.

it seek to preserve a wide variety of cultures in the interests of greater long-term creativity and security?

Nuclear power. Electricity and other forms of energy are essential to a modern civilization, but traditional sources like petroleum and natural gas have become increasingly expensive. Nuclear power offers a partial solution to the problem but presents certain dangers: Nuclear materials or equipment might be used by terrorists or militarists and there is also the danger of accidental explosions or leaks of radioactivity.

Can we live with nuclear power? Can we live without it? If we must live with nuclear power, what can be done to minimize the risks?

Crime. Many social thinkers once believed that crime would disappear as more people were given jobs and education. Unfortunately, in many instances crime has risen—not fallen—as society provided more schools and better economic conditions.

What can be done to reduce crime in the future? Should penalties be heavier?

Electronic voting. New communications technology makes it feasible for citizens to vote or express their views regularly and often on a wide range of issues without leaving their homes.

Should governments move to create "electronic town-meetings" on a nationwide basis to decide public issues? Should political leaders be subject to instant recall by an electronic ballot?

Family breakdown. The family has traditionally been the social institution charged with producing and rearing children to become members of the future society. But the traditional family consisting of father, mother, and children appears to be disintegrating. The divorce rate has risen dramatically in recent years and more women who have children outside of wedlock have elected to keep their children rather than turning them over to adoptive parents.

What, if anything, should be done to halt the disintegration of families?

Growing armaments. The world's nations constantly strive to acquire new weapons for "security" purposes. Yet the growing arsenal of weaponry seems to decrease rather than increase international security. Many developing countries devote more of their precious foreign exchange to acquiring weapons than to alleviating the suffering of their poverty-stricken people.

What can be done to slow or halt the arms race? What can be done to prevent a Third World War?

Migration. People want the freedom to travel and live wherever they choose, but when they settle in other nations they often create cultural and political problems within their adopted countries. As transportation systems improve, it becomes physically easier for people to move from one country to another and increasing numbers may elect to do so, but violence and turmoil may result if millions of people from low-wage countries elect to move into nations where wages are higher.

What limits should be placed on international migration?

Poverty in wealthy nations. During the past few decades, living standards have risen dramatically in the developed countries, but there remain wide discrepancies in individual income. Many countries have sought to insure that all citizens have a certain minimum standard of living by means of welfare payments and free goods and services. Meanwhile, governments require well-to-do people to pay increasingly heavy taxes as their incomes rise. Some Swedish scholars have recently proposed that limits be placed on consumption—for instance, a legal limit on the amount of housing or the number of automobiles a person can have. In Sweden and elsewhere, however, experience suggests that policies aimed at equalizing the standard of living tend to undermine the incentive to work. And when people work less they produce less for everyone.

Should there be a minimum standard of living to which all citizens are entitled even if they refuse to work? Should there be limits placed on people's consumption of

"The oceans, which once were regarded as the common property of mankind, are now passing into national or even private ownership."

goods? Should a government try to give all its citizens the same standard of living?

Credentialing. Many employers now insist that prospective employees have certain educational credentials, such as a university degree. But such a requirement often excludes from consideration people who would be excellent employees.

Should it be made illegal to discriminate on the grounds of alleged educational deficiencies?

Rich versus poor nations. The citizens of some nations enjoy a very high average standard of living while people in other countries are desperately poor. Some people feel that the rich countries should provide free assistance to the poor nations—much like the welfare payments made within the rich countries to their poorer residents. Other people feel that the rich nations have no such obligation and the poor countries are poor because they have not curbed their population growth.

How should the rich countries help the poor countries? Is it fair to tax the poor in the rich countries in order to help the rich in the poor countries?

Ownership of the oceans. Nations have steadily extended their claims to the areas of the ocean off their shores. Thus the oceans, which once were regarded as the common property of mankind, are now passing into national or even private ownership. National or private ownership is not necessarily bad: If the resources of the ocean are to be developed, property rights must be respected, that is, ocean farmers who cultivate sea plants and fish need to have their investment protected or they will cease their efforts. At present, many resources of the ocean are being ruthlessly exploited because no nation owns them and therefore has the incentive and authority to safeguard them.

Who should own the oceans? How should conflicting claims to ocean resources be mediated?

Automobiles. Most people like to use automobiles for many of their transportation needs, because the automobile offers door-to-door convenience, privacy, etc. But the automobile uses large amounts of increasingly scarce and expensive gasoline and exacts huge human costs (about 50,000 dead and 100,000 maimed each year in the United States alone).

Should the use of the automobile be discouraged? If so, what alternative forms of transportation should be promoted?

Extended human life. Biomedical research may soon discover how to extend the human life-span by many years. Conceivably, some people alive today may live to be two or three centuries old. If so, some people might retire at 65 and collect retirement benefits for centuries, eventually bankrupting pension funds and imposing a huge burden on younger workers.

How is society to adjust to an extended human life-span?

The value of human life. Many people are kept alive in hospitals even though they are in acute pain or may never be able to resume normal living. Keeping them alive is enormously expensive both to their relatives and to society at large. The dilemma is becoming increasingly important as medical technology makes it possible to keep many people alive indefinitely provided special equipment is used.

Is life an absolute value that society can deprive none of its members of under no circumstances? Who should bear the cost of keeping people alive when they have no reasonable expectation of being able to resume their normal lives again?

The cost of government regulations. Governments have instituted numerous regulations to protect consumers against dangerous products, workers against accidents and discrimination, and citizens against pollution. But the cost of meeting government regulations now is widely viewed as a problem in its own right. Large companies pass the costs along to customers in the form of higher prices; small firms often find themselves unable to cope with complex government regulations and survive; new innovative technology—which could improve productivity (thereby reducing inflation)—is held back by regulations.

What should be done to make government regulations less burdensome? Should there be "sunset" provisions so that legislation automatically becomes inoperative after a certain number of years?

New technology. Progress depends on the development of new technology, but new technology often turns out to be dangerous or to have undesirable long-term consequences (thalidomide and DDT, for example).

How can technology best be assessed in advance of its wide-scale use? How can we have technology assessment without technology "ar-

"It is not the task of futurists to predict exactly what people will do in the future, but rather to help people to understand the possibilities of the future so that a better world can be created."

Little girls and biomedicine: As medical technology advances, more and more parents will choose the sex of their children. Already, it is possible for a pregnant woman to learn, through amniocentesis, the sex of the child she is carrying; if the child is not of the desired sex, she can have an abortion. During the 1980s, gender may increasingly be a matter of choice rather than chance.

Photo: National Education Association

restment"—a serious slowdown in the arrival of useful new technology that can help us to accomplish our purposes?

Destruction of the environment. In many areas, people are destroying their natural environment in a wide variety of ways. Nepalese peasants searching for firewood denude the neighboring mountains, exposing the soil to rains that wash it away, leaving bare rock. Elsewhere, cattle farmers allow herds to become too numerous for grasslands and the land turns to desert.

What should be done to halt environmental destruction?

Extinction of many animals and plants. The growing human population is threatening the survival of thousands of plant and animal species. By the end of the twentieth century, some researchers believe that over half a million species now alive may be extinct.

What can be done to preserve these species, which might be extremely valuable to humanity at some later date?

Artificial conception and birthing. Biologists have succeeded in fertilizing human ova outside a woman's uterus. Soon it may be possible to rear embryos in a solution until they are ready to be "born." It may be possible for a laboratory to produce thousands or even millions of living babies that could be sold to whoever wants them.

Who are the parents of babies born in this manner—that is, who is responsible for bringing them up? Should such experiments be allowed to continue?

Smoking. Medical experts now are generally agreed that cigarette smoking can seriously harm people's health—perhaps even when they themselves do not smoke but are in the presence of smokers.

Should smoking be banned in public places? Do people have the right to smoke even though they are harming their health in doing so?

Drugs. The use of marijuana and narcotics has increased greatly since World War II. Illegal trafficking in drugs is now immense: Narcotics are said to be America's largest import except for petroleum.

Should marijuana be legalized but regulated like alcohol? What about the "hard" drugs like heroin and cocaine?

Responsibility for health. Society has long acted as if physicians and hospitals were responsible for people's health. Research has revealed, however, that an individual can do more to keep himself healthy than the best doctor—simply by following such rules as not smoking, not overeating, etc.

If individuals refuse to follow health rules, should they be punished for doing so, since the cost of their illness may have to be borne by others?

Terrorism. Many groups have discovered that they can get attention for their cause by committing acts of violence—bombings, assassinations, kidnappings, etc.

How can the international community put down terrorism without unduly restricting people's freedoms?

Disorder in the financial world. Rampant inflation and the declining dollar have led to widespread uncertainty in international finance. Billions of dollars now race back and forth across national frontiers beyond the control of central banks. A sudden movement somewhere could trigger an international economic crisis.

What can be done to restore order in the world's financial markets?

Choosing the sex of one's children. Physicians are currently developing various means whereby parents can

Solar collectors on an eight-story office building in Minneapolis provide 50% of the energy needed for space heat, 80% of the cooling, and all of the hot water. Solar power offers one approach to meeting the critical need for energy during the 1980s.
Photo: Honeywell, Inc.

decide whether to have a boy or a girl.

Should parents choose the sex of their children? What can be done to prevent the sex-ratio from becoming unbalanced so that there are far more men than women—or vice versa?

Overpopulation. Some countries are doing little to reduce the birthrate of their people with the result that the nations are increasingly overpopulated. With more and more mouths to feed, the food supply inevitably runs short.

If a nation refuses to curb its population growth, is the international community required to alleviate the resulting starvation? If so, will that not make the problem just that much worse?

Licenses for parents. Many children today are born to parents who do not want them or cannot provide adequately for them. Society now requires people to have a license if they want to drive but makes no such requirement for becoming a parent, which is a much more complex task.

Should people who want to have children be required to meet at least some minimum standards?

The policy choices listed above constitute only a sampling of the stupendous agenda that faces the world today. Since these choices are genuine, we cannot know in advance what will eventually be chosen. We can, of course, state our views about what *should* be chosen, but that is a very different thing from predicting successfully the choices that will be made.

Return of Halley's Comet

There are, of course, a few predictions for the 1980s that can be made with considerable confidence. For instance, Halley's comet will make one of its rare appearances to earthly viewers. It will be most visible in the sky from November 1985 to January 1986. Halley's comet travels in a very long orbit around the sun; most of the time it is too far away from earth to be visible to the naked eye, but every 76 years the comet comes into the neighborhood of the earth. Sir Edmund Halley, for whom the comet is named, was a close friend of Sir Isaac Newton, and he used Newton's gravitation principle to calculate the orbits of a number of comets. In doing so, Halley noticed that a comet was reported in the same position of the sky in 1531, 1607, and 1682, moving along an identical path. Halley theorized that all the sightings were of a single comet and predicted that the comet would reappear in another 76 years. Halley's predictions were confirmed in 1759 and again in 1835 and 1910.

Such precise predictions by astronomers fill ordinary mortals with awe. They seem to challenge futurists thinking about human life on earth to produce predictions of similar accuracy and precision. Some futurists may feel ashamed that they fail so miserably in their efforts to make accurate precise predictions, but they should not feel any chagrin. Halley's comet is an inanimate object that has no choice about its actions and operates far beyond the power of human beings to alter its behavior. By contrast, futurists deal with the actions of human beings, who constantly make choices about what they shall do. Unlike astronomers, whose predictions are hardly more than statements about the periodic behavior of inanimate objects, futurists are engaged in the far more complex task of helping human beings to create a better future world. It is not the task of futurists to predict exactly what people will do in the future, but rather to help people to understand the possibilities of the future so that a better world can be created.

The 1980s promise to be a fascinating and exciting decade. We human beings will be making many crucial choices that will affect human life profoundly in an infinite number of ways. The 1980s will probably not be a tranquil period—too many powerful forces have been set loose for that—but it may be a period during which great progress will be made despite much turbulence. One thing we can feel pretty confident about: We will make a great many choices that will dramatically shape the world in which we will live in the years to come. The fact of choice is what makes the future of the world so unpredictable—but far more interesting than Halley's comet.

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Part II — World Review Court Hearing

- The World Review Court will convene at its scheduled time. A chief judge is selected to preside over the preceedings. The entire class now assumes the role of World Court Judges. (The presenters of the technology assessment reports retain their group role when they give their report.) The panel of World Court Judges is an impartial body charged with the task to evaluate the development of new technologies. As a World Court Judge you must now broaden your concerns from that of your interest group to that of the world-at-large. It is your responsibility that new technolgies be developed wisely and justly. You must weigh each decision carefully after considering the benefits as well as disadvantages. A good question to ask yourself before making a decision is, "How will the new technology affect an individual's right to a safe and healthy environment?

- The groups will rotate giving their reports. That is, a member of the first group will give one technology report and then a member of the second group will give one report and so on. The process continues until all 16 reports are heard.

- Each World Court Judge will receive an evaluation sheet, Handout 4. This sheet contains the instructions for judging each technology and a record sheet. Review this form carefully before starting.
- After a report has been presented, the judges will decide whether or not that technology is acceptable. On the evaluation sheet are a list of *objectives*. Review this list and decide if the technology is objectionable on any of these counts.
- *Raising an Objection.* Any judge may raise an objection. When he/she is recognized by the Chief Judge, he/she will anounce the objection and *explain why* the technology is undesirable. The panel of judges will vote on the objection: *Yes* for agreement; *No* for disagreement.
- A proposed technology which receives *two or more objections* will not be accepted. If there are no objections, the technology is automatically judged as acceptable.
- The reports and evaluation will proceed as described until all 16 have been heard. At the conclusion of the Hearing the list of accepted technologies will be read by the Presiding Judge. The interest group with the most technologies accepted is declared the group which has successfully accomplished its goal.

Discussion Questions

- **Which group was most successful in achieving its goals? Why do you suppose its technologies were accepted?**
- **Do you think that the technologies accepted were the most important ones? What are your reasons?**
- **How would you categorize the technologies which were accepted? Labor saving devices? New materials? High speed communication and travel? More powerful tools? Food production technologies? Others?**
- **What values were held as most important by the judges? Was there much disagreement between the judges? In what areas was there greatest disagreement?**
- **Are there groups of people who will benefit more than others from the technologies?**
- **Are there technologies on the list you selected which are in conflict with others? That is, is it possible to promote all the technologies and not be counterproductive?**
- **How will lifestyles change with the new technologies? What are your predictions?**
- **Is there any possibility that the selected technolgies might be misused?**
- **Will society have to change dramatically in order to adapt to the new technologies? Is this desirable?**

WORLD REVIEW COURT EVALUATION SHEET

Objections

The new technology will:

1 — Violate individual freedom and freedom of choice
2 — Cause irreparable damaging change to the environment of human life
3 — Create overcrowding and widespread famine
4 — Create large scale unemployment
5 — Invade personal privacy
6 — Produce dangerous waste products
7 — Enable government to make more of our personal decisions
8 — Produce conflict between nations and increase likelihood of global warfare
9 — Increase the gap between the rich and the poor nations
10 — Drain nonrenewable natural resources
11 — Create economic instability as a result of government overspending
12 — Increase social unrest and conflict by widening the gap between the rich and poor
13 — Increase competition among nations for scarce resources
14 — Produce situations where people feel alienated, useless or a lack of control over their own lives
15 — Leads to "Big Brotherism" — government increases the monitoring of its citizens
16 — Reduces the value of human life and human dignity

Instructions:

- Record the title of the new technology presented and the name of the group sponsoring it. During the presentation, you are to decide whether or not the technology will create/cause any of the objections listed above.
- Try to think of different ways in which the technology might be used. Ask yourself the questions: "What might happen if the technology were used or controlled by an unscrupulous person or group?", "What might happen if it were used in ways other than its intended purpose?", or "Will it create unresolvable problems for future generations?"
- When the presenter is finished, you, as judges, may in turn, cite an objection. Record the number of the objection in the box next to the title. The entire panel of judges will then vote on that objection: *Yes* — if they agree with the objection, *No* — if they disagree with the objection. Record the number of *Yes* votes and *No* votes. Other objections will be made and voted upon in a similar manner. Do this until all objections are heard. A technology which produces *two* or more objections will be eliminated. Therefore, if the judges agree upon two objections, it is unnecessary to hear any additional objections. Proceed to the next technology until all 16 technologies have been heard and evaluated.

RECORD SHEET

Technology	Name of Group	Objection Number and Record of Vote									
1			Yes No		Yes No		Yes No		Yes No		Yes No
2			Yes No		Yes No		Yes No		Yes No		Yes No
3			Yes No		Yes No		Yes No		Yes No		Yes No
4			Yes No		Yes No		Yes No		Yes No		Yes No
5			Yes No		Yes No		Yes No		Yes No		Yes No
6			Yes No		Yes No		Yes No		Yes No		Yes No
7			Yes No		Yes No		Yes No		Yes No		Yes No
8			Yes No		Yes No		Yes No		Yes No		Yes No
9			Yes No		Yes No		Yes No		Yes No		Yes No
10			Yes No		Yes No		Yes No		Yes No		Yes No
11			Yes No		Yes No		Yes No		Yes No		Yes No
12			Yes No		Yes No		Yes No		Yes No		Yes No
13			Yes No		Yes No		Yes No		Yes No		Yes No
14			Yes No		Yes No		Yes No		Yes No		Yes No
15			Yes No		Yes No		Yes No		Yes No		Yes No
16			Yes No		Yes No		Yes No		Yes No		Yes No

Part III — Discussion of Results and Scenario of Future

Since you have devoted much effort and thought to this simulation, you will now have additional opportunity to express your ideas and feelings about future technologies. The class discussion also serves to summarize some of the major ideas introduced during the course of the activity.

SCENARIO OF THE FUTURE

In small groups or individually, write a scenario describing the future. That is, how do you envision the world of the future which has developed the technologies that you proposed? What major changes will occur and what are the effects?

Writing a Scenario

The term "scenario" was used to describe a type of comedy play developed by medieval Italian actors. The scenario was the written plot but contained no set dialogue. The actors simply improvised the dialogue when they acted out their role as outlined. In the motion picture business scenarios have come to mean a plot, a screenplay or the script.

In more recent years the scenario has acquired a new meaning. It describes a tool/technique used by planners, futurists, businessmen and other types of decision makers to help them examine a future possibility in greater detail. The scenario serves as an interesting, flexible and creative way to project into the future and explore possibilities and different alternatives. It is in essence a story describing a future event. Scenarios examine the series of steps leading to a future goal or investigate effects of different decisions. They help the writer or policy maker make better decisions because they force him/her to consider how changes interact with other changes in a more dynamic manner, through descriptions of the effects and consequences of the future possibilities. By working out the details of the interaction, the future situation becomes clearer. and one can begin to identify relationships that have not been considered before.

When writing a scenario, one typically begins by asking the question, "What if. . .?" One possible change leads to other changes and the scenario story unfolds. Your scenario can be presented in a number of different ways: a science fiction story, a short skit, a planning diagram, visionary drawings, a cartoon story or even a simple outline of events. The main purpose is to explore alternative possibilities and show where they might lead. It allows you to test the different underlying assumptions and values of a future goal.

In this scenario writing exercise you will expand upon the ideas that emerged from your technology assessment and speculate about the world of the future which has applied the technologies selected by the court.

- Will it be a world in which you will enjoy living?
- What are the many changes that will come about and what types of adjustment will you need to make?
- How does one technology affect other technologies?
- Will all the changes be beneficial?

Your scenario will help you evaluate the decisions you made as World Review Court Judges.

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